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Original Articles

THE INTEGRATION OF FACIAL SKELETAL VARIANTS

A SERIAL CEPHALOMETRIC ROENTGENOGRAPHIC ANALYSIS OF CRANIOFACIAL FORM AND GROWTH

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JENKINTOWN, PA.

INTRODUCTION

DIAGNOSIS and treatment of malocclusion depend upon a knowledge of the form and growth of the human face. Hence, this subject is not only of academic interest to the orthodontist, but also of the utmost clinical importance.

Many studies have described the morphology and development of the human face in general terms; yet, such information is of limited clinical usefulness when one deals with individual variation. More important are the manner in which a given face may vary from the average and the factors which lead to such variation.

The present investigation was undertaken to obtain a better understanding of the conformation and growth adjustments of the individual facial pattern. Forty-seven persons were examined by the method of serial cephalo-

Condensation of the 1954 Prize Essay of the American Association of Orthodontists, presented at the 50th annual meeting, Chicago, May, 1954.

Original thesis submitted as partial fulfillment of requirements for the Master of Science degree, University of Illinois, 1952.

metric roentgenology to determine the variation of the relative size and growth of cranial and facial structures and the effect of the integration of such variants upon the facial profile.

REVIEW OF THE LITERATURE

In 1931 Broadbent[1] introduced a roentgenographic method by which standardized serial roentgenograms of the growing person could be obtained. The advantages of the method were realized, and in 1937 Broadbent[2] presented his first series of diagrams in which he illustrated an orderly growth pattern of the face of the normal child. Following this, Brodie,[3] in 1941, published a serial quantitative study on the growth of the human head from the third month to the eighth year of life. During the age span studied, little change in the behavior of the mean pattern was found, although deviation from the mean was noted in individual persons.

Björk,[4] in 1947, concluded, from a cross-sectional roentgenographic comparison of males 12 years of age and 20 to 22 years of age, that in the later ages the face increased in vertical height with an accompanying increase in prognathism. Similar observations were noted by Lande[5] in 1951.

That the interest of orthodontists in the problem of head growth is very great is attested by their many contributions to the literature of the field. In addition to those already referred to, have been the reports of Adams (1939), Elman (1940), Baldridge (1941), Wylie (1944), Renfroe (1948), Shoenwetter (1948), Staph (1948), Drelich (1948), Elsasser (1948), Riedel (1948), Craig (1950), Gilmour (1950), Blair (1952), Sanborn (1952), and others, all of which have represented efforts to determine the primary etiological factors of dental malocclusion.[6-19] The results of these investigations have gradually led to a complete reversal of point of view. Whereas it formerly was held that dental occlusion and function were the chief determinants of facial development, these studies have indicated strongly that the opposite is true, namely, that facial conformation and development largely determine the occlusion of the teeth. Hellman[20] had indicated this in 1937, when he showed that faces, although possessing excellent occlusion, exhibited wide variation in their development.

A broader concept of individual variation was indicated, and in 1948 Downs[21] introduced his analysis of facial form in which he sought to evaluate the balance and harmony of the individual facial profile. In that same year, Wylie[22] advanced his "analysis of anteroposterior dysplasia." Whereas Downs evaluated the profile, Wylie segmented the face according to anatomic landmarks and sought to determine the variation of the internal facial morphology related to a particular profile type. He found that the effect of a marked discrepancy of an individual part could be "cancelled out" by a deviation in the opposite direction of another part and result in good facial harmony; similarly, the small discrepancies in the same direction might be additive and lead to marked total disharmony. Brodie (1946),[23] in his paper entitled "Facial Patterns—a Theme on Variation," had stated an identical point of view.

These latter studies directed toward the analysis of variation of facial profiles have concerned themselves mainly with depth dimensions. Insufficient attention has been placed on variation of facial height, the influence of the configuration of the cranial base, and the integration of all such variants in the total facial pattern. Further, these studies of a "static" nature, based upon the morphology of faces at a single age period, are of limited clinical usefulness. More important is an understanding of the growth behavior of the individual face and the modification of the facial profile as related to time.

It was the purpose of the present investigation to analyze: (1) the integration of skeletal variants resulting in differing facial types, (2) the growth behavior and adjustments of cranial and facial structures within the individual face, and (3) the manner in which such growth may modify facial form.

MATERIAL

The investigation was based upon serial lateral cephalometric roentgenograms of a group of forty-seven Caucasians, composed of twenty-five males and twenty-two females, none of whom received orthodontic treatment.

The sample consisted of a random selection of skeletal patterns, the choice of material based solely upon age and the quality of roentgenograms. Each series consisted of two roentgenograms: the first representative of the age period, 8 years ± 1 year; the second, the age period, 16 years ± 1 year. The mean of the initial age period was 8.49 years for males, 8.79 years for females. The mean age difference between serial roentgenograms was 7.72 years for males and 7.66 years for females.

Forty-two persons exhibited excellent occlusions or Class I malocclusions

METHODOLOGY

The technique of cephalometric roentgenology and the validity of the method for the study of human facial growth have been adequately described by Broadbent in 1931 and Brodie in 1941, and therefore will not be discussed at this time.[1, 3, 24]

DEFINITION OF LANDMARKS

The definition of all points described was verified by x-raying skulls marked by lead discs on points or areas in question. To avoid confusion in terminology, several unfamiliar landmarks and definitions deserve emphasis (Fig. 1).

The anthropometric point, basion (BA), defined as the median point of the anterior margin of the foramen magnum, has been employed in this study as representative of the posterior limit of that segment of the cranial base which may influence facial development. In a large number of roentgenograms this point can be located accurately by following the image of the slope of the inferior border of the basilar part of the occipital bone to its posterior limit. Basion will be found to lie above the tip of the odontoid process of the second cervical vertebra. The distinct image of the anterior margin of the foramen magnum may be obscured by a dense shadow of the anterior

border of the occipital condyles. In such instances, the most superior point of the anterior margin of the base of the occipital condyle has been substituted for the anthropometric point. The location of basion on the standard lateral cephalometric roentgenogram was verified both by roentgenograms of skull material and by mid-sagittal laminagraphic roentgenograms of living persons. Fig. 2 illustrates the point in a standard cephalometric roentgenogram and the identical landmark in a midsagittal laminagram of the same person.

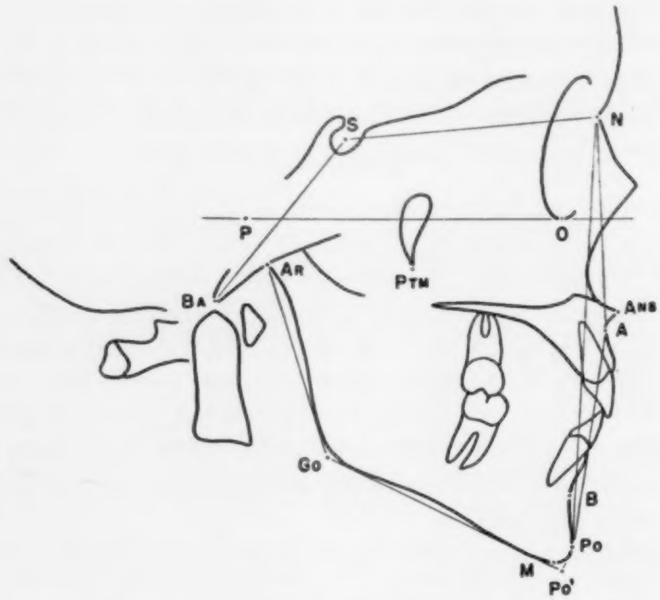


Fig. 1.—Tracing of lateral cephalometric roentgenogram showing points and planes employed in the study.

The point, articulare (Ar), described by Björk[4] in 1947, has been redefined as the point of intersection of the images of the posterior border of the mandible and the inferior border of the basilar part of the occipital bone. Gonion was represented as a constructed point (Go). The angle formed by the mandibular plane and the ramus plane has been termed the gonial angle (Go∠). The deviation of the ramus plane from a vertical (90 degree) relation to the Frankfort plane was referred to as the angle of ramus inclination (Ri∠), representing the inclination of the posterior border of the ramus in the facial pattern.

METHOD OF ANALYSIS

To correlate facial form and the postural position of the head, the Frankfort horizontal plane was employed as a plane of orientation. The use of the Frankfort plane of reference in serial cephalometric roentgenographic growth studies requires that this plane bear a constant relationship to a cranial base plane. In this study the sella-nasion plane was selected.

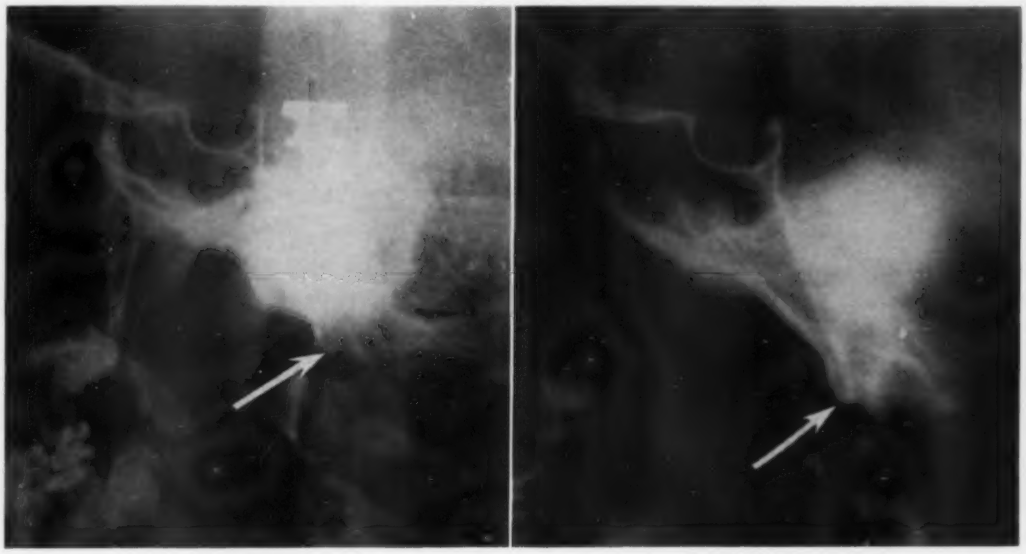
The constant between these two planes may represent the relationship exhibited in the initial roentgenogram of a series or a mean relationship de-

rived from the entire series. Due to the difficulty of accurately locating the porion point in cephalometric roentgenograms, the mean Frankfort horizontal plane of each series of roentgenograms was selected as the plane of reference for that series.

Each tracing was then divided by a coordinate system of lines, the mean Frankfort horizontal plane as the abscissa, lines perpendicular to the abscissa as ordinates. Measurements of craniofacial depth were taken parallel to the abscissa. Vertical height was measured along the ordinates.

Fig. 3 is a diagram of the method of analysis. For simplicity, the depth and height analyses have been separated.

Because it was the purpose of this study to appraise the face against a right angle coordinate system, attention was directed toward effective rather than absolute dimensions. Only when an absolute dimension (length or height) lies in a plane parallel to the ordinate or abscissa is it identical with the effective dimension.



A. *B.*

Fig. 2.—Lateral cephalometric roentgenogram (*A*) and midsaggital laminagram (*B*) of same person, showing location of basion.

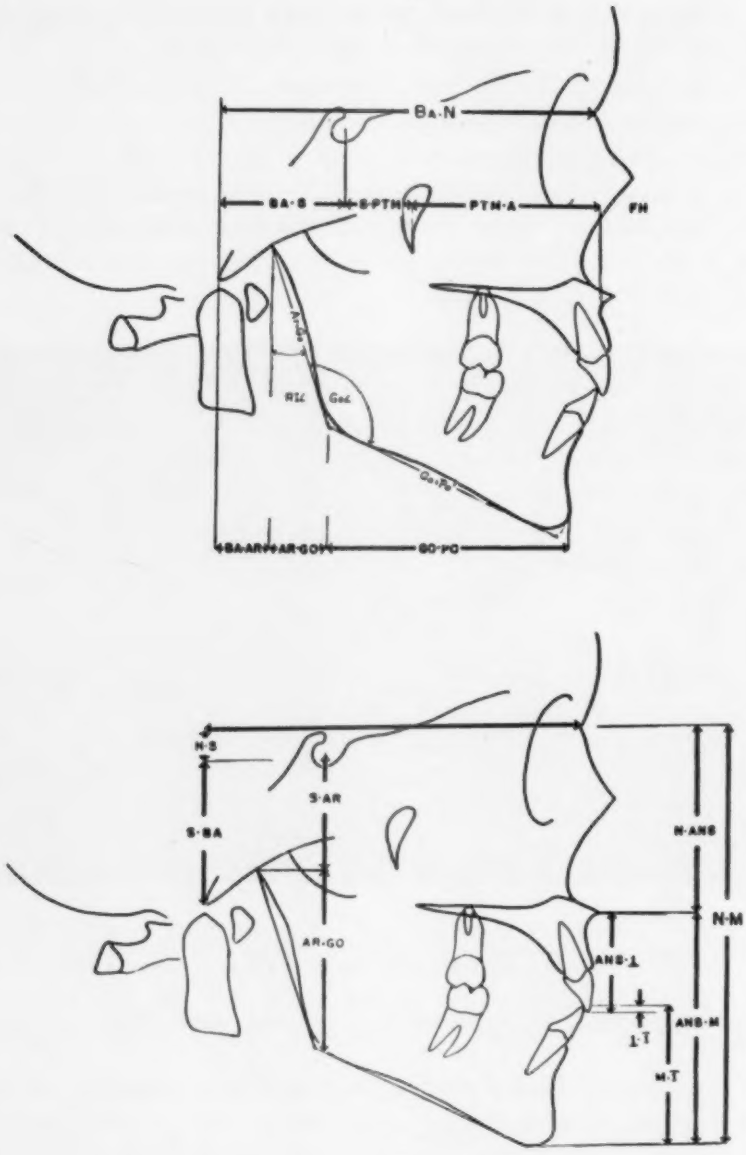
The following method of analysis was carried uniformly throughout all tables.

Depth of the cranial base was analyzed first and recorded as the horizontal length between points basion and nasion. To evaluate middle face prognathism, the depth of the middle face (basion to point *A*) and its contributing segments (basion to sella, sella to *Ptm*, and *Ptm* to point *A*) were expressed as a percentage of the base depth, basion to nasion.

The contribution of the mandible to the prognathism of the lower face was first analyzed as to its position relative to the cranial base (basion to articulare) and then evaluated to show the effect of mandibular form, size, and position on

its horizontal contribution, articulare to pogonion. For purposes of analysis, the mandibular contribution was divided into that segment which was contributed by the ramus (articulare to gonion) and that contributed by the body (gonion to pogonion). The variables affecting these horizontal lengths were then evaluated.

A.



B.

Fig. 3.—Coordinate method of analysis of craniofacial depth (*A*) and height (*B*).

The length, articulare to gonion, would vary as the absolute height of the ramus (articulare to gonion, *A.L.*) and the degree of forward inclination of the ramus in the pattern, which has been termed the angle of ramus inclination

(RI∠). The greater the angle and the greater the ramus height, the more the contribution of the mandibular ramus to the depth of the lower face. The smaller the angle, the more the contribution of the ramus to posterior face height.

The length gonion to pogonion, would vary as the absolute length of the body of the mandible (gonion to pogonion, *A.L.*) and the inclination of the mandibular plane (MPL∠). The greater the length of the body and the more horizontal the inclination of the mandibular plane, the more the contribution of the length of the mandibular body to lower face depth.

The significance of the gonial angle (Go∠) was evaluated in the reading of the angle of ramus inclination (RI∠), which represents the resultant of the gonial angle minus the mandibular plane angle minus 90 degrees.

The vertical height of the face was analyzed in a similar manner by measurements taken along ordinates drawn perpendicular to the abscissa. All vertical measurements were expressed as a percentage of the anterior face height, nasion-menton (*N·M*). An index of the relationship of face height to face depth was then established by expressing anterior face height as a percentage of the cranial base depth (BA·N).

The facial angle and angle of convexity described by Downs (1948) were employed as the index of profile typing. These angles encompass both horizontal and vertical relations of the profile and correlate directly with the coordinate analysis described.

The coordinate method of analysis permited the appraisal of the integration of the actual size and relative proportions of the various craniofacial structures of each face at the two age periods. Growth increments, changes of angular relationships, and changes of craniofacial proportions were quantitated by comparing the serial data of each case and calculating the difference. To establish a basis for the evaluation of individual cases, the combined data of the sample were grouped according to sex and subjected to statistical analysis.

FINDINGS

The findings were divided into two major phases. The first phase constituted the statistical appraisal of the morphology and growth of the total sample. The second phase was the analysis of individual patterns, the characteristics of the total sample serving as a basis for comparison.

APPRAISAL OF THE TOTAL SAMPLE

The first part of the evaluation of the group characteristics was the analysis of craniofacial form of the 8 year ± 1 year age group.

The means, standard deviations, and ranges of variability of craniofacial proportions were determined (Table I) and a "Standard Deviation Diagram" was devised (modified after Hellman) to illustrate graphically the variability of proportions. For simplicity, one standard deviation has been employed (Fig. 4).

TABLE I. MEANS AND VARIABILITY OF CRANIOFACIAL PROPORTIONS OF 47 CHILDREN AT THE AGE OF 8 YEARS ± 1 YEAR

MEASUREMENT		UNIT	MEAN	STANDARD DEVIATION	RANGE
	Ba·N	mm	83.1	3.75	75.0/ 92.5
	Ba·S	%Ba·N	24.9	2.19	19.9/ 29.7
	S·Ptm	%Ba·N	20.7	2.82	15.6/ 26.8
	Ptm·A	%Ba·N	51.4	2.59	44.8/ 57.0
	Ba·A	%Ba·N	97.0	3.24	90.7/105.1
	Ba·Ar	%Ba·N	9.9	2.63	5.2/ 15.4
D	Ar·Po	%Ba·N	80.2	6.48	63.2/ 94.3
	Ba·Po	%Ba·N	90.1	6.38	73.6/107.0
E	Ar·Go(A.L.)	%Ba·N	45.2	3.20	37.5/ 52.5
P	RI ∠	°	9.8	4.98	-2.0/+19.0
	Ar·Go	%Ba·N	7.6	3.95	-1.1/ 14.5
T	Go·Po′(A.L.)	%Ba·N	76.9	3.99	67.4/ 84.6
H	MPl ∠	°	26.4	4.07	18.0/ 36.0
	Go·Po	%Ba·N	72.6	4.44	62.8/ 81.5
	Go ∠	°	126.2	5.41	114.0/138.0
	MPl ∠(-)	°	26.4	4.07	18.0/ 36.0
	RI ∠	°	9.8	4.98	-2.0/ 19.0
	N·S	%N·M	7.1	3.69	-0.5/ 15.4
H	S·Ar	%N·M	26.5	1.79	20.6/ 30.4
	Ar·Go	%N·M	38.5	2.76	32.0/ 44.8
E	S·Go	%N·M	65.0	3.79	58.2/ 73.0
I	N·Ans	%N·M	45.8	2.18	41.3/ 50.5
G	Ans·1	%N·M	23.8	2.18	18.7/ 27.4
	M·$\bar{1}$	%N·M	33.4	1.76	29.5/ 36.8
H	1·$\bar{1}$ (-)	%N·M	3.0	2.45	-4.5/ 8.8
T	Ans·M	%N·M	54.2	2.18	49.5/ 58.7
	N·M	%Ba·N	115.3	6.56	95.1/127.3
	Facial ∠	°	84.8	3.37	77.0/ 94.0
	Convexity ∠	°	+4.8	4.14	-2.0/+15.0

The Standard Deviation Diagram shown is divided into two parts—depth and height. The uppermost segment of the "depth" diagram represents the variability of the depth of the cranial base (basion to nasion). All proportions of craniofacial depth were evaluated as a percentage of the basion to nasion dimension.

The "middle face" segment represents the variability of the relative size of dimensions contributing to middle face prognathism (the proportions, basion to sella, sella to *Ptm, Ptm* to point *A*, and the summation, basion to point *A*). The total percentage, basion to point *A*, exhibited slightly more variability than contributing units.

The "lower face" segment illustrates the variability of proportions contributing to lower face prognathism (the proportions, basion to articulare, articulare to gonion, gonion to pogonion, and the summation basion to pogonion). The diagram also shows that summations of proportions were more

variable than individual contributing units. Note that the variability of lower face prognathism was greater than that of middle face prognathism and cranial base depth.

The uppermost segment of the "height" diagram illustrates the variability of the relation of face height to depth. The variability of this proportion and that of lower face prognathism were the most variable proportions found.

The "posterior face" segment shows that the variability of the proportion, nasion to sella, representing the height of the anterior cranial base, was similar to that of the posterior face height, sella to gonion. The variability of both exceeded the sella to articulare and articulare to gonion dimensions.

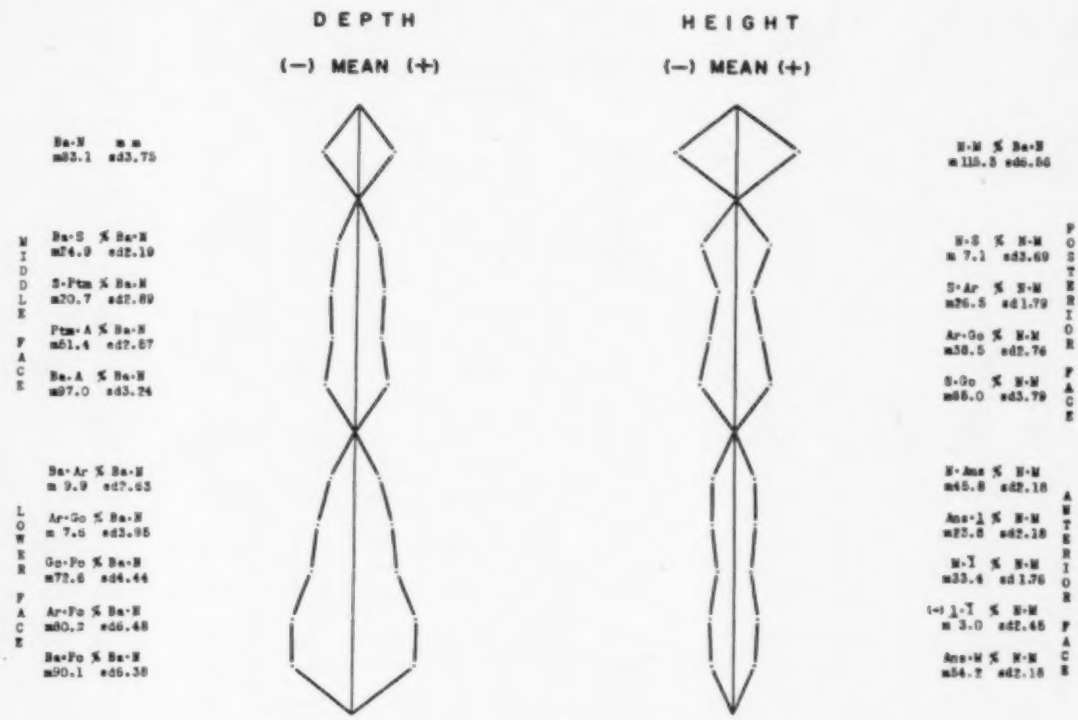


Fig. 4.—Standard deviation diagram of craniofacial proportions of forty-seven children, aged 8 years ± 1 year (modified after Hellman).

The "anterior face" segment represents the variability of the component proportions of anterior face height, which were the least variable proportions found.

No statistically significant differences of facial form were found between the sexes at this age.

The second part of the analysis of the group behavior was the evaluation of growth between the initial age 8 years ± 1 year and 16 years ± 1 year (Table II).

It was found that, while males only slightly exceeded females in depth increments, the male face far exceeded the female in vertical growth.

In depth, both sexes exhibited the greatest increment in the lower face, with the middle face only slightly exceeding the cranial base.

The male face exhibited greater increment of facial height than depth, with more vertical growth in the anterior face than in the posterior.

TABLE II. MEANS AND VARIABILITY OF INCREMENTS IN CRANIOFACIAL DEPTH AND HEIGHT OF TWENTY-FIVE BOYS AND TWENTY-TWO GIRLS FROM AGES 8 YEARS ± 1 YEAR TO 16 YEARS ± 1 YEAR

		BOYS MEAN AGE SPAN: 7.72 YEARS				GIRLS MEAN AGE SPAN: 7.66 YEARS			
MEASUREMENT		UNIT	MEAN	STANDARD DEVIATION	RANGE	UNIT	MEAN	STANDARD DEVIATION	RANGE
DEPTH	Ba·N	mm	9.6	2.14	5.5/13.0	mm	7.4	2.36	3.0/12.0
	Ba·S	mm	2.8	1.69	0.0/ 5.5	mm	3.0	1.57	0.0/ 7.0
	S·Ptm	mm	1.6	1.06	0.0/ 4.0	mm	1.1	1.30	0.0/ 5.5
	Ptm·A	mm	5.5	1.53	3.0/ 9.5	mm	4.1	1.39	1.5/ 6.0
	Ba·A	mm	9.9	2.36	6.0/17.5	mm	8.2	2.17	3.0/13.5
	Ba·Ar	mm	0.0	1.55	-2.5/ 3.0	mm	0.0	1.09	-2.5/ 2.0
	Ar·Po	mm	13.7	4.34	8.0/25.0	mm	11.5	3.03	7.5/17.5
	Ba·Po	mm	13.7	4.80	7.5/28.0	mm	11.5	3.01	7.5/17.5
	Ar·Go(A.L.)	mm	11.8	3.21	6.5/19.5	mm	9.1	2.15	4.5/13.0
	RI∠	°	-1.3	2.35	-6.0/+4.0	°	-0.7	2.67	-4.0/+5.0
	Ar·Go	mm	0.8	1.69	-2.5/ 4.5	mm	1.2	2.14	-2.0/ 5.0
	Go·Po′(A.L.)	mm	12.5	4.01	7.0/26.5	mm	9.5	2.58	5.0/15.5
	MPl ∠	°	-3.3	3.14	-8.0/+4.0	°	-4.1	2.16	-8.0/ 0.0
	Go·Po	mm	12.9	3.97	6.5/25.0	mm	10.3	2.71	6.5/18.0
	Go ∠	°	-4.6	3.36	-10.0/+1.0	°	-4.8	3.07	-9.0/+3.0
	MPl ∠(-)	°	-3.3	3.14	-8.0/+4.0	°	-4.1	2.16	-8.0/ 0.0
	RI ∠	°	-1.3	2.35	-6.0/+4.0	°	-0.7	2.67	-4.0/+5.0
HEIGHT	N·S	mm	0.9	0.60	0.0/ 2.5	mm	0.6	0.50	0.0/ 1.5
	S·Ar	mm	5.1	2.10	0.5/ 9.0	mm	2.8	1.45	0.5/ 6.0
	Ar·Go	mm	11.6	3.49	5.5/20.5	mm	9.1	2.08	5.5/13.0
	S·Go	mm	16.7	3.77	11.0/28.0	mm	11.9	3.17	4.5/19.0
	N·Ans	mm	9.0	3.14	0.0/18.5	mm	5.7	2.13	0.0/ 9.5
	Ans·1̄	mm	3.8	2.31	-0.5/ 8.5	mm	2.6	1.81	-0.5/ 6.0
	M·1̄	mm	7.1	2.28	3.5/13.5	mm	4.4	1.69	1.0/ 8.5
	1·1̄ (-)	mm	0.8	1.87	-3.0/ 4.5	mm	1.2	1.45	-1.5/ 4.5
	Ans·M	mm	10.1	3.73	3.0/18.5	mm	5.8	2.85	-1.5/11.0
	N·M	mm	19.1	5.04	10.5/37.0	mm	11.5	3.14	7.0/19.0

The female face exhibited similar vertical growth of the anterior and posterior face and of the depth of the lower face.

An appraisal of variation showed that growth increments were more variable among males than among females.

The changes in craniofacial form between the two age periods can be summarized by the use of the Standard Deviation Diagram (Fig. 5). By plotting the older age group means against the original means, represented by the median line in each segment, changes in form can be illustrated. The heavy solid line is used for the male, the broken line for the female.

The first segment under "Depth" illustrates the actual millimeter increase in the depth of the cranial base (basion to nasion). All other readings are a percentage of this depth.

The middle segment under "Depth" shows that middle face prognathism (basion to point A) increased only slightly in both sexes.

The bottom of the lower segment shows that lower face prognathism (basion to pogonion) exhibited definite increase, male and female showing similar change.

Under "Height," the first segment illustrates that the proportion of face height to depth increased in the male and in the female, with the male face becoming proportionally longer than the female.

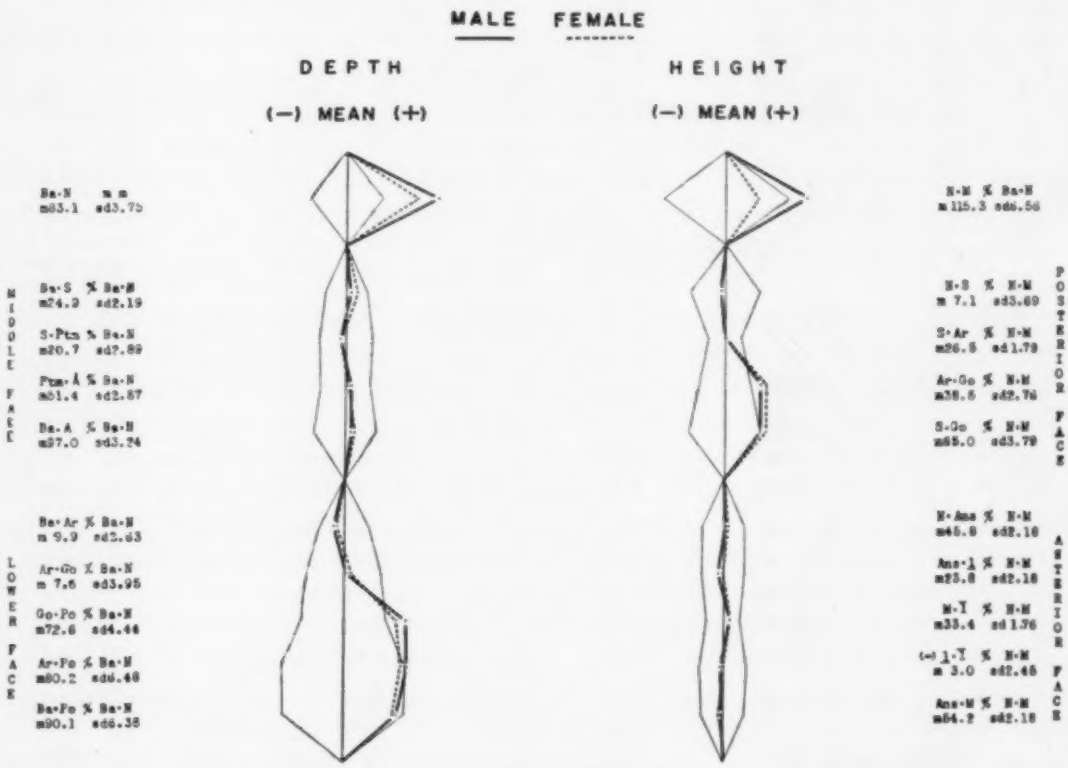


Fig. 5—Diagram illustrating average change of craniofacial proportions according to sex from ages 8 years ± 1 year to 16 years ± 1 year by plotting the mean change against the original means of the 8 years ± 1 year Standard Deviation Diagram.

The middle segment shows that the relative height of the posterior face (sella to gonion) increased in both sexes.

Last, the proportions of the component segments of the anterior face height were found to exhibit minimal change.

Both sexes showed similar increase of the facial angle and decrease in the convexity of the profile.

In general, changes of facial proportions were more variable among males than among females. The increase of lower face prognathism and the proportions of face height to depth exhibited maximum variability in both sexes.

TABLE III. MEANS AND VARIABILITY OF CHANGES IN CRANIOFACIAL PROPORTIONS OF TWENTY-FIVE BOYS AND TWENTY-TWO GIRLS FROM AGES 8 YEARS ± 1 YEAR TO 16 YEARS ± 1 YEAR

MEASUREMENT		BOYS MEAN AGE SPAN: 7.72 YEARS				GIRLS MEAN AGE SPAN: 7.66 YEARS			
		UNIT	MEAN	STANDARD DEVIATION	RANGE	UNIT	MEAN	STANDARD DEVIATION	RANGE
DEPTH	Ba·S	%Ba·N	+0.5	1.40	-2.1/ +2.9	%Ba·N	+1.2	1.22	-1.6/ +4.2
	S·Ptm	%Ba·N	-0.5	1.22	-3.1/ +1.6	%Ba·N	-0.5	1.66	-2.3/ +4.6
	Ptm·A	%Ba·N	+0.7	1.82	-2.5/ +4.0	%Ba·N	+0.3	1.32	-2.9/ +1.7
	Ba·A	%Ba·N	+0.7	1.81	-2.4/ +5.3	%Ba·N	+1.0	1.44	-1.9/ +3.7
	Ba·Ar	%Ba·N	-1.1	1.63	-3.8/ +2.3	%Ba·N	-0.8	1.12	-3.4/ +1.2
	Ar·Po	%Ba·N	+6.7	4.69	-0.4/+15.6	%Ba·N	+6.1	3.66	-0.5/+12.9
	Ba·Po	%Ba·N	+5.6	4.92	-1.8/+17.9	%Ba·N	+5.3	2.97	+0.4/ +9.6
	Ar·Go(A.L.)	%Ba·N	+7.8	3.31	+1.4/+15.7	%Ba·N	+6.4	2.25	+0.3/+10.0
	RI ∠	°	-1.3	2.35	-6.0/ +4.0	°	-0.7	2.67	-4.0/ +5.0
	Ar·Go	%Ba·N	+0.2	1.77	-2.9/ +4.6	%Ba·N	+0.6	2.45	-3.3/ +5.6
	Go·Po′(A.L.)	%Ba·N	+5.8	4.01	-1.1/+18.0	%Ba·N	+4.2	2.71	-0.5/+11.3
	MPl ∠	°	-3.3	3.14	-8.0/ +4.0	°	-4.1	2.16	-8.0/ 0.0
	Go·Po	%Ba·N	+6.5	4.20	-0.1/+17.1	%Ba·N	+5.5	2.84	+0.3/+11.9
	Go ∠	°	-4.6	3.36	-10.0/ +1.0	°	-4.8	3.07	-9.0/ +3.0
	MPl ∠(-)	°	-3.3	3.14	-8.0/ +4.0	°	-4.1	2.16	-8.0/ 0.0
	RI ∠	°	-1.3	2.35	-6.0/ +4.0	°	-0.7	2.67	-4.0/ +5.0
HEIGHT	N·S	%N·M	-0.4	0.60	-2.1/ +0.4	%N·M	-0.3	0.50	-1.3/ +0.5
	S·Ar	%N·M	0.0	1.84	-2.9/ +3.3	%N·M	-0.1	1.62	-3.1/ +2.7
	Ar·Go	%N·M	+3.8	2.41	-0.2/ +8.4	%N·M	+4.4	1.51	-1.4/ +7.5
	S·Go	%N·M	+3.8	2.40	-0.3/ +7.4	%N·M	+4.3	2.63	-0.7/+10.2
	N·Ans	%N·M	+0.2	2.18	-8.0/ +2.6	%N·M	+0.4	1.81	-4.5/ +5.8
	Ans·1̄	%N·M	-0.6	1.58	-4.8/ +4.0	%N·M	-0.1	1.45	-2.4/ +2.8
	M·1̄	%N·M	+0.7	1.68	-3.0/ +4.3	%N·M	+0.7	1.21	-1.7/ +3.4
	1·1̄(-)	%N·M	+0.3	1.99	-3.8/ +3.5	%N·M	+1.0	1.43	-1.7/ +4.1
	Ans·M	%N·M	-0.2	2.18	+8.0/ -2.6	%N·M	-0.4	1.81	+4.5/ -5.8
	N·M	%Ba·N	+8.6	4.85	+0.7/+24.0	%Ba·N	+3.4	2.72	-1.5/ +8.0
	Facial ∠	°	+3.0	2.44	-1.0/ +9.0	°	+2.8	1.72	0.0/ +5.0
	Convexity ∠	°	-4.7	4.10	+5.0/-13.0	°	-4.1	3.81	+3.0/-11.0

The major sex difference found in the growth analysis was the male face exhibiting a marked increase in vertical height, the face becoming proportionally longer than that of the female (Table III).

APPRAISAL OF INDIVIDUAL PATTERNS

In the previous section, attention was directed to the mean craniofacial pattern and to the changes in its proportions brought about by growth. This was essential to the establishment of the framework of reference. However, as has been indicated by previous studies, such management of data frequently tends

to obscure rather than reveal important facts. Particularly does it seem to lead to oversimplification of matters which cannot be simplified without losing value as diagnostic aids.

The present part of the work is an analysis of the form and growth behavior of individual facial types. Only a few cases will be briefly presented.

Before discussing the first case, attention is drawn to the method of superimposing tracings, which differs from conventional methods. The relationship of head growth and the postural position of the head is illustrated by superimposed tracings registered on basion and oriented with the sella-nasion planes parallel. This method of superimposing permits the evaluation of head growth as related to a point which is common in position to both the head and the cervical vertebrae. The method also correlates with the coordinate analysis described.

Using basion as the point of reference, growth in the cranial base carries the upper face forward and upward away from the foramen magnum. In some persons, growth in the posterior cranial base contributes primarily to vertical height. In others, it contributes almost solely to depth.

The most stable area found was the basion-articulare area. This suggests that in the later ages there is little change in the relation of the temporomandibular joint to the foramen magnum. Increase in the depth of the lower face seems to be due solely to mandibular growth in a downward and forward direction.

Fig. 6*A* is a tracing of a person with an excellent occlusion. The profile at the initial age was slightly retrognathic and somewhat straight. At the later age, the lower face became more prominent, the mandibular plane more horizontal, the profile more prognathic and slighlty concave.

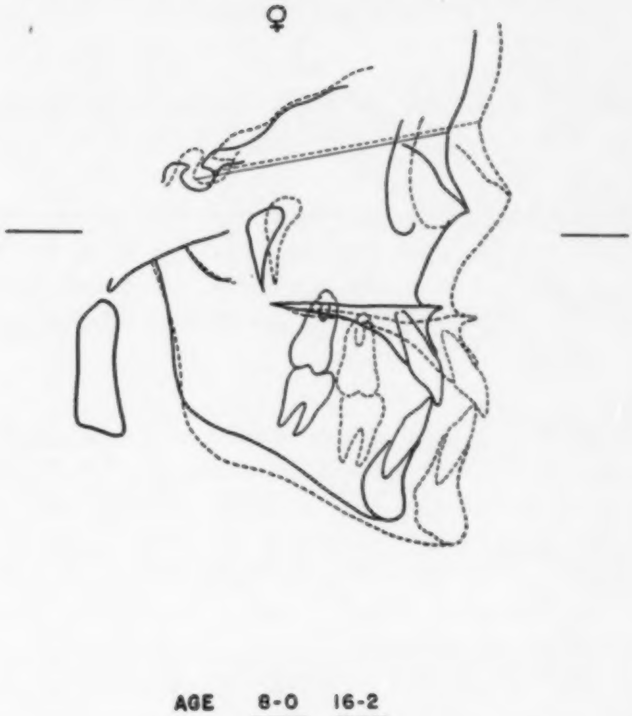
The analysis of the case is found in Table IV and may be illustrated by the use of the Standard Deviation Diagram (Fig. 6*B*). When individual cases are plotted against the standard, all values which fall to the right of the mean indicate values which are larger than the average. Values to the left of the mean are smaller than the average. In this manner, the contribution of each variable to facial prognathism and facial height can be represented graphically. Developmental changes of facial proportions are shown in the same diagram by plotting the values of facial proportions exhibited at the later age. This is represented by a broken line.

The analysis shows that, at the original age, middle face prognathism (basion to point *A*) was less than average, approaching the low range of the standard deviation. Although the basion to sella dimension exceeded the mean value, the sella to *Ptm* and maxillary lengths were proportionally smaller than average. The resultant effect was less than average middle face prognathism.

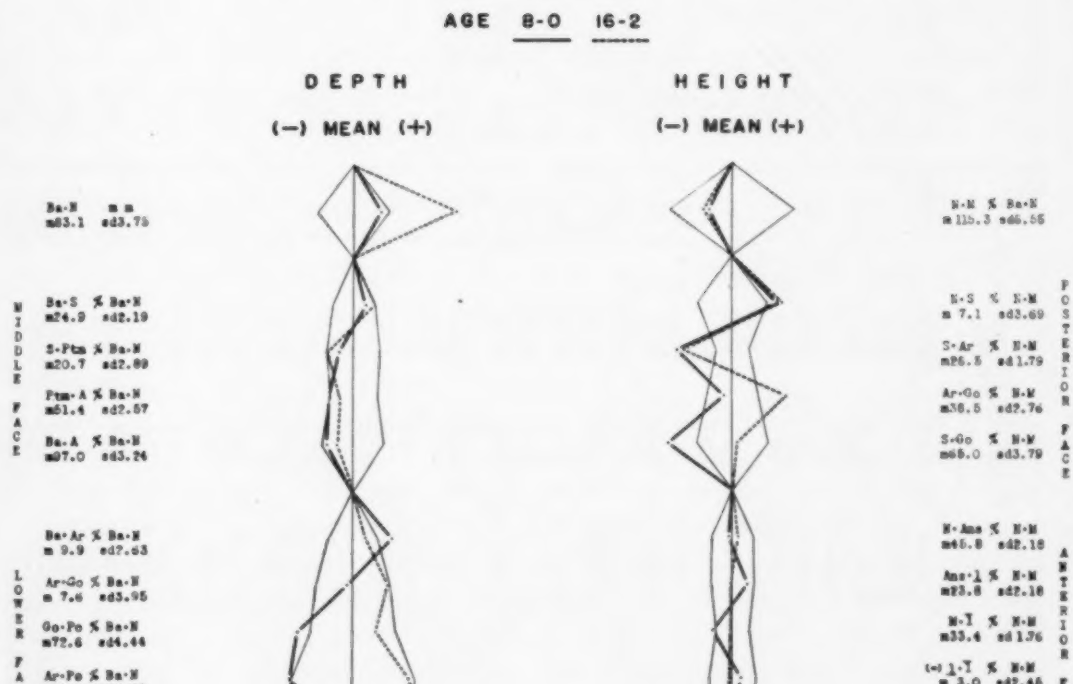
Lower face prognathism was less than average, but within the standard deviation. The mandible was found to be in a relatively forward position (basion to articulare); however, the effective mandibular contribution was below average. The combined effect of a small mandibular body and slightly higher mandibular plane angle resulted in the reduced lower face prognathism.

TABLE IV. CASE 18

	SEX: FEMALE	CRANIOFACIAL PROPORTIONS AGE: 8·0				GROWTH INCREMENTS AGE: 8·0 TO 16·2				CHANGES OF CRANIOFACIAL PROPORTIONS AGE: 8·0 TO 16·2			
	MEASUREMENT	UNIT	NO. 18	MEAN	STANDARD DEVIATION	UNIT	NO. 18	MEAN	STANDARD DEVIATION	UNIT	NO. 18	MEAN	STANDARD DEVIATION
	Ba·N	mm	86.0	83.1	3.75	mm	8.0	7.4	2.36	-	-	-	-
	Ba·S	%Ba·N	26.2	24.9	2.19	mm	3.0	3.0	1.57	%Ba·N	+1.0	+1.2	1.22
	S·Ptm	%Ba·N	19.2	20.7	2.82	mm	0.5	1.1	1.30	%Ba·N	-1.1	-0.5	1.66
	Ptm·A	%Ba·N	48.8	51.4	2.59	mm	5.0	4.1	1.39	%Ba·N	+1.2	+0.3	1.32
	Ba·A	%Ba·N	94.2	97.0	3.24	mm	8.5	8.2	2.17	%Ba·N	+1.1	+1.0	1.44
D	Ba·Ar	%Ba·N	14.0	9.9	2.63	mm	-1.5	0.0	1.09	%Ba·N	-2.8	-0.8	1.12
E	Ar·Po	%Ba·N	73.8	80.2	6.48	mm	17.5	11.5	3.03	%Ba·N	+12.4	+6.1	3.66
	Ba·Po	%Ba·N	87.8	90.1	6.38	mm	16.0	11.5	3.01	%Ba·N	+9.6	+5.3	2.97
P	Ar·Go(A.L.)	%Ba·N	43.6	45.2	3.20	mm	10.0	9.1	2.15	%Ba·N	+6.9	+6.4	2.25
	RI ∠	°	10.0	9.8	4.98	°	+3.0	-0.7	2.67	°	+3.0	-0.7	2.67
T	Ar·Go	%Ba·N	7.0	7.6	3.95	mm	4.5	1.2	2.14	%Ba·N	+4.2	+0.6	2.45
H	Go Po′(A.L.)	%Ba·N	72.6	76.9	3.99	mm	10.0	9.5	2.58	%Ba·N	+4.5	+4.2	2.71
	MPl ∠	°	28.0	26.4	4.07	°	-8.0	-4.1	2.16	°	-8.0	-4.1	2.16
	Go·Po	%Ba·N	66.8	72.6	4.44	mm	13.0	10.3	2.71	%Ba·N	+8.2	+5.5	2.84
	Go ∠	°	128.0	126.2	5.41	°	-5.0	-4.8	3.07	°	-5.0	-4.8	3.07
	MPl ∠(-)	°	28.0	26.4	4.07	°	-8.0	-4.1	2.16	°	-8.0	-4.1	2.16
	RI ∠	°	10.0	9.8	4.98	°	+3.0	-0.7	2.67	°	+3.0	-0.7	2.67
	N·S	%N·M	11.8	7.1	3.69	mm	1.5	0.6	0.50	%N·M	+0.5	-0.3	0.50
H	S·Ar	%N·M	20.6	26.5	1.79	mm	2.5	2.8	1.45	%N·M	+0.7	-0.1	1.62
	Ar·Go	%N·M	37.6	38.5	2.76	mm	10.0	9.1	2.08	%N·M	+6.5	+4.4	1.51
E	S·Go	%N·M	58.2	65.0	3.79	mm	12.5	11.9	3.17	%N·M	+7.2	+4.3	2.63
I	N·Ans	%N·M	45.4	45.8	2.18	mm	5.0	5.7	2.13	%N·M	+1.0	+0.4	1.81
G	Ans·1	%N·M	25.3	23.8	2.18	mm	0.5	2.6	1.81	%N·M	-1.6	-0.1	1.45
	M·1̄	%N·M	31.4	33.4	1.76	mm	4.5	4.4	1.69	%N·M	+1.8	+0.7	1.21
H	1·1̄(-)	%N·M	2.1	3.0	2.45	mm	+1.5	1.2	1.45	%N·M	+1.2	+1.0	1.43
T	Ans·M	%N·M	54.6	54.2	2.18	mm	3.5	5.8	2.85	%N·M	-1.0	-0.4	1.81
	N·M	%Ba·N	112.8	115.3	6.56	mm	8.5	11.5	3.14	%Ba·N	-0.6	+3.4	2.72
	Facial ∠	°	84.0	84.8	3.37	-	-	-	-	°	+5.0	+2.8	1.72
	Convexity ∠	°	+1.0	+4.8	4.14	-	-	-	-	°	-9.0	-4.1	3.81



A.



B.

Fig. 6.—Case 18. *A*, Superimposed tracings of lateral cephalometric roentgenograms registered on basion and oriented in the mean Frankfort plane.

B, Diagram illustrating the craniofacial proportions and growth changes of Case 18 plotted against the 8 years ± 1 year Standard Deviation Diagram.

Table V. Case 7

	SEX: FEMALE	CRANIOFACIAL PROPORTIONS AGE: 9·11				GROWTH INCREMENTS AGE: 9·11 TO 16·1				CHANGES OF CRANIOFACIAL PROPORTIONS AGE: 9·11 TO 16·1			
	MEASUREMENT	UNIT	NO. 7	MEAN	STANDARD DEVIATION	UNIT	NO. 7	MEAN	STANDARD DEVIATION	UNIT	NO. 7	MEAN	STANDARD DEVIATION
	Ba·N	mm	86.0	83.1	3.75	mm	11.0	7.4	2.36	-	-	-	-
	Ba·S	%Ba·N	27.3	24.9	2.19	mm	5.0	3.0	1.57	%Ba·N	+2.1	+1.2	1.22
	S·Ptm	%Ba·N	20.3	20.7	2.82	mm	0.0	1.1	1.30	%Ba·N	-2.3	-0.5	1.66
	Ptm·A	%Ba·N	46.5	51.4	2.59	mm	3.5	4.1	1.39	%Ba·N	-1.7	+0.3	1.32
	Ba·A	%Ba·N	94.1	97.0	3.24	mm	8.5	8.2	2.17	%Ba·N	-1.9	+1.0	1.44
D	Ba·Ar	%Ba·N	11.0	9.9	2.63	mm	2.0	0.0	1.09	%Ba·N	+0.9	-0.8	1.12
E	Ar·Po	%Ba·N	73.2	80.2	6.48	mm	7.5	11.5	3.03	%Ba·N	-0.5	+6.1	3.66
	Ba·Po	%Ba·N	84.2	90.1	6.38	mm	9.5	11.5	3.01	%Ba·N	+0.4	+5.3	2.97
P	Ar·Go(A.L.)	%Ba·N	38.9	45.2	3.20	mm	4.5	9.1	2.15	%Ba·N	+0.3	+6.4	2.25
	RI ∠	°	9.0	9.8	4.98	°	-4.0	-0.7	2.67	°	-4.0	-0.7	2.67
T	Ar·Go	%Ba·N	6.4	7.6	3.95	mm	-2.0	1.2	2.14	%Ba·N	-2.8	+0.6	2.45
H	Co·Po′(A.L.)	%Ba·N	67.4	76.9	3.99	mm	10.0	9.5	2.58	%Ba·N	+5.8	+4.2	2.71
	MPl ∠	°	26.0	26.4	4.07	°	0.0	-4.1	2.16	°	0.0	-4.1	2.16
	Go·Po	%Ba·N	66.8	72.6	4.44	mm	9.5	10.3	2.71	%Ba·N	+2.3	+5.5	2.84
	Go ∠	°	125.0	126.2	5.41	°	-4.0	-4.8	3.07	°	-4.0	-4.8	3.07
	MPl ∠(-)	°	26.0	26.4	4.07	°	0.0	-4.1	2.16	°	0.0	-4.1	2.16
	RI ∠	°	9.0	9.8	4.98	°	-4.0	-0.7	2.67	°	-4.0	-0.7	2.67
	N·S	%N·M	7.7	7.1	3.69	mm	0.5	0.6	0.50	%N·M	-0.8	-0.3	0.50
H	S·Ar	%N·M	27.6	26.5	1.79	mm	1.0	2.8	1.45	%N·M	-2.0	-0.1	1.62
	Ar·Go	%N·M	36.5	38.5	2.76	mm	5.5	9.1	2.08	%N·M	+1.4	+4.4	1.51
E	S·Go	%N·M	64.1	65.0	3.79	mm	6.5	11.9	3.17	%N·M	-0.6	+4.3	2.63
I	N·Ans	%N·M	45.3	45.8	2.18	mm	5.5	5.7	2.13	%N·M	+0.5	+0.4	1.81
G	Ans·1	%N·M	26.0	23.8	2.18	mm	3.5	2.6	1.81	%N·M	+0.6	-0.1	1.45
	M·1̄	%N·M	35.4	33.4	1.76	mm	3.0	4.4	1.69	%N·M	-0.9	+0.7	1.21
H	1·1̄(-)	%N·M	6.7	3.0	2.45	mm	+1.0	1.2	1.45	%N·M	+0.2	+1.0	1.43
T	Ans·M	%N·M	54.7	54.2	2.18	mm	5.5	5.8	2.85	%N·M	-0.5	-0.4	1.81
	N·M	%Ba·N	105.2	115.3	6.56	mm	11.0	11.5	3.14	%Ba·N	-0.6	+3.4	2.72
	Facial ∠	°	81.0	84.8	3.37	-	-	-	-	°	0.0	+2.8	1.72
	Convexity ∠	°	+6.0	+4.8	4.14	-	-	-	-	°	-4.0	-4.1	3.81

In height, the anterior cranial base (nasion to sella) exceeded the upper range of the standard deviation, while the posterior face height (sella to gonion) fell below the range, the greater deficiency found in the sella to articulare segment.

At the later age, middle face prognathism increased slightly, while the prognathism of the lower face exceeded the standard deviation. The proportion of posterior face height relative to the anterior face increased and the mandibular plane became more horizontal.

The facial angle increased 5 degrees and the convexity of the face decreased 9 degrees.

Although the case exhibited average growth in the middle face, the increment in the lower face exceeded the standard deviation. Analysis revealed that the absolute increments of the mandibular body and ramus, as well as the decrease in the gonial angle, were close to average. In addition, the mandible was positioned slightly posteriorly. The explanation for this average increment was found in an excessive reduction of the mandibular plane angle and increase in the angle of ramus inclination, which resulted in a greater effective contribution of both the mandibular body and the ramus. The explanation for the reduction of the mandibular plane angle was found in the height analysis. While the vertical growth of the posterior face was only slightly greater than the mean, the growth of the anterior face was below average, due primarily to the small increase in the upper dental height.

Each case studied presented a different pattern of integration. Most cases, although differing in type and in growth adjustments, tended to show similar modification of the profile with age. Where individual characteristics appeared to be abnormal, it was their integration in the total pattern which determined harmony or disharmony.

Orthodontists deal with faces exhibiting malocclusions and, unfortunately, in such a group many exceptions to the average are found. For this reason, several cases presenting the common types of malocclusions will be discussed.

Figs. 7*A* and 8*A* represent two cases exhibiting Class II, Division 1 malocclusions. Referring to their respective Standard Deviation Diagrams, (Figs. 7*B* and 8*B*) and Tables V and VI, it may be seen that, although these faces had similar malocclusions, their facial patterns differed widely. The female (Fig. 7*A*) showed less than average middle face prognathism, but was quite deficient in the lower face, due primarily to the effect of a smaller mandibular body. In the male (Fig. 8*A*), a different condition existed in which there was more than average lower face prognathism, but excessive prognathism of the middle face due to a proportionally larger maxilla and excessive sella-pterygomaxillary dimension.

The growth behavior of both cases varied from the average. In each, middle face prognathism decreased slightly, with lower face prognathism de-

TABLE VI. CASE 36

	SEX: MALE	CRANIOFACIAL PROPORTIONS AGE: 7·11				GROWTH INCREMENTS AGE: 7·11 TO 15·8				CHANGES OF CRANIOFACIAL PROPORTIONS AGE: 7·11 TO 15·8			
	MEASUREMENT	UNIT	NO. 36	MEAN	STANDARD DEVIATION	UNIT	NO. 36	MEAN	STANDARD DEVIATION	UNIT	NO. 36	MEAN	STANDARD DEVIATION
DEPTH	Ba·N	mm	82.5	83.1	3.75	mm	10.0	9.6	2.14	-	-	-	-
	Ba·S	%Ba·N	23.1	24.9	2.19	mm	2.5	2.8	1.69	%Ba·N	+0.2	+0.5	1.40
	S·Ptm	%Ba·N	24.8	20.7	2.82	mm	1.5	1.6	1.06	%Ba·N	-1.0	-0.5	1.22
	Ptm·A	%Ba·N	53.3	51.4	2.59	mm	4.0	5.5	1.53	%Ba·N	-1.5	+0.7	1.82
	Ba·A	%Ba·N	101.2	97.0	3.24	mm	8.0	9.9	2.36	%Ba·N	-2.3	+0.7	1.81
	Ba·Ar	%Ba·N	12.2	9.9	2.63	mm	0.0	0.0	1.55	%Ba·N	-1.4	-1.1	1.63
	Ar·Po	%Ba·N	83.0	80.2	6.48	mm	8.0	13.7	4.34	%Ba·N	-0.4	+6.7	4.69
	Ba·Po	%Ba·N	95.2	90.1	6.38	mm	8.0	13.7	4.80	%Ba·N	-1.8	+5.6	4.92
	Ar·Go(A.L.)	%Ba·N	46.1	45.2	3.20	mm	10.0	11.8	3.21	%Ba·N	+5.8	+7.8	3.31
	RI ∠	°	13.0	9.8	4.98	°	-5.0	-1.3	2.35	°	-5.0	-1.3	2.35
	Ar·Go	%Ba·N	9.7	7.6	3.95	mm	-1.0	0.8	1.69	%Ba·N	-2.2	+0.2	1.77
	Go·Po′(A.L.)	%Ba·N	76.4	76.9	3.99	mm	10.5	12.5	4.01	%Ba·N	+3.0	+5.8	4.01
	MPl ∠	°	22.0	26.4	4.07	°	+4.0	-3.3	3.14	°	+4.0	-3.3	3.14
	Go·Po	%Ba·N	73.3	72.6	4.44	mm	9.0	12.9	3.97	%Ba·N	+1.8	+6.5	4.20
	Go ∠	°	125.0	126.2	5.41	°	-1.0	-4.6	3.36	°	-1.0	-4.6	3.36
	MPl ∠(-)	°	22.0	26.4	4.07	°	+4.0	-3.3	3.14	°	+4.0	-3.3	3.14
	RI ∠	°	13.0	9.8	4.98	°	-5.0	-1.3	2.35	°	-5.0	-1.3	2.35
HEIGHT	N·S	%N·M	9.2	7.1	3.69	mm	0.5	0.9	0.60	%N·M	-1.2	-0.4	0.60
	S·Ar	%N·M	27.6	26.5	1.79	mm	3.5	5.1	2.10	%N·M	-2.3	0.0	1.84
	Ar·Go	%N·M	39.4	38.5	2.76	mm	11.0	11.6	3.49	%N·M	+2.0	+3.8	2.41
	S·Go	%N·M	67.0	65.0	3.79	mm	14.5	16.7	3.77	%N·M	-0.3	+3.8	2.40
	N·Ans	%N·M	43.2	45.8	2.18	mm	10.0	9.0	3.14	%N·M	+0.4	+0.2	2.18
	Ans·1	%N·M	22.2	23.8	2.18	mm	7.5	3.8	2.31	%N·M	+3.1	-0.6	1.58
	M·1̄	%N·M	34.6	33.4	1.76	mm	6.5	7.1	2.28	%N·M	-1.0	+0.7	1.68
	1·1̄(-)	%N·M	0.0	3.0	2.45	mm	+1.5	0.8	1.87	%N·M	+2.5	+0.3	1.99
	Ans·M	%N·M	56.8	54.2	2.18	mm	12.5	10.1	3.73	%N·M	-0.4	-0.2	2.18
	N·M	%Ba·N	112.1	115.3	6.56	mm	22.5	19.1	5.04	%Ba·N	+12.2	+8.6	4.85
	Facial ∠	°	87.0	84.8	3.37	-	-	-	-	°	-1.0	+3.0	2.44
	Convexity ∠	°	+7.0	+4.8	4.14	-	-	-	-	°	-2.0	-4.7	4.10

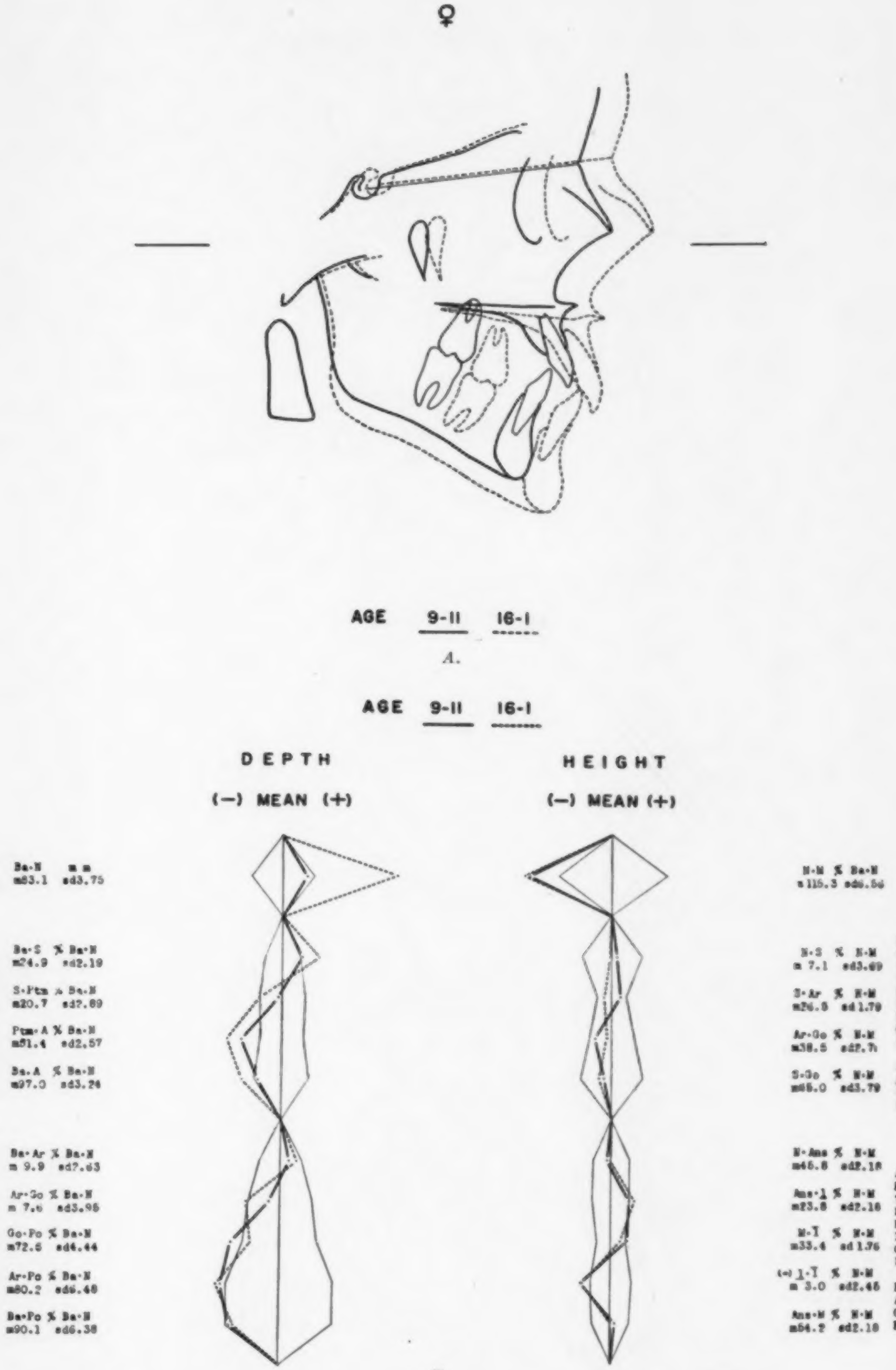
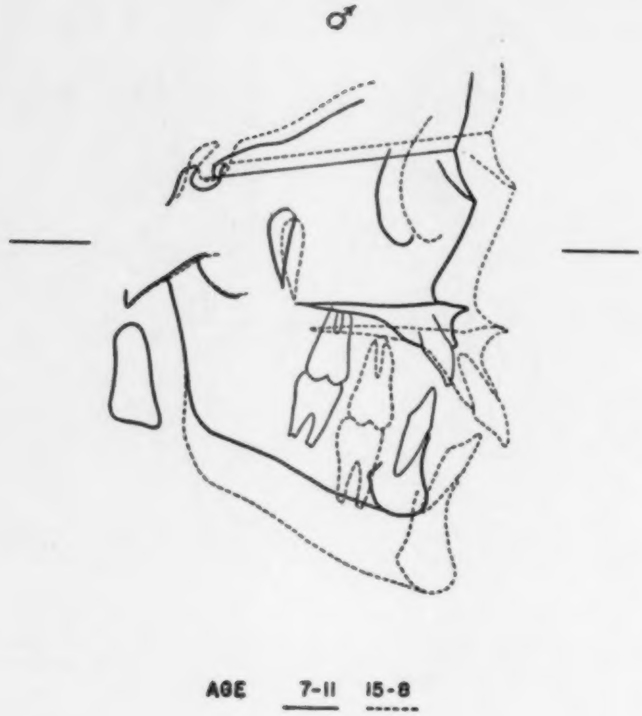


Fig. 7.—Case 7. *A*, Superimposed tracings of lateral cephalometric roentgenograms registered on basion and oriented in the mean Frankfort plane.

B, Diagram illustrating the craniofacial proportions and growth changes of Case 7 plotted against the 8 years ± 1 year Standard Deviation Diagram.



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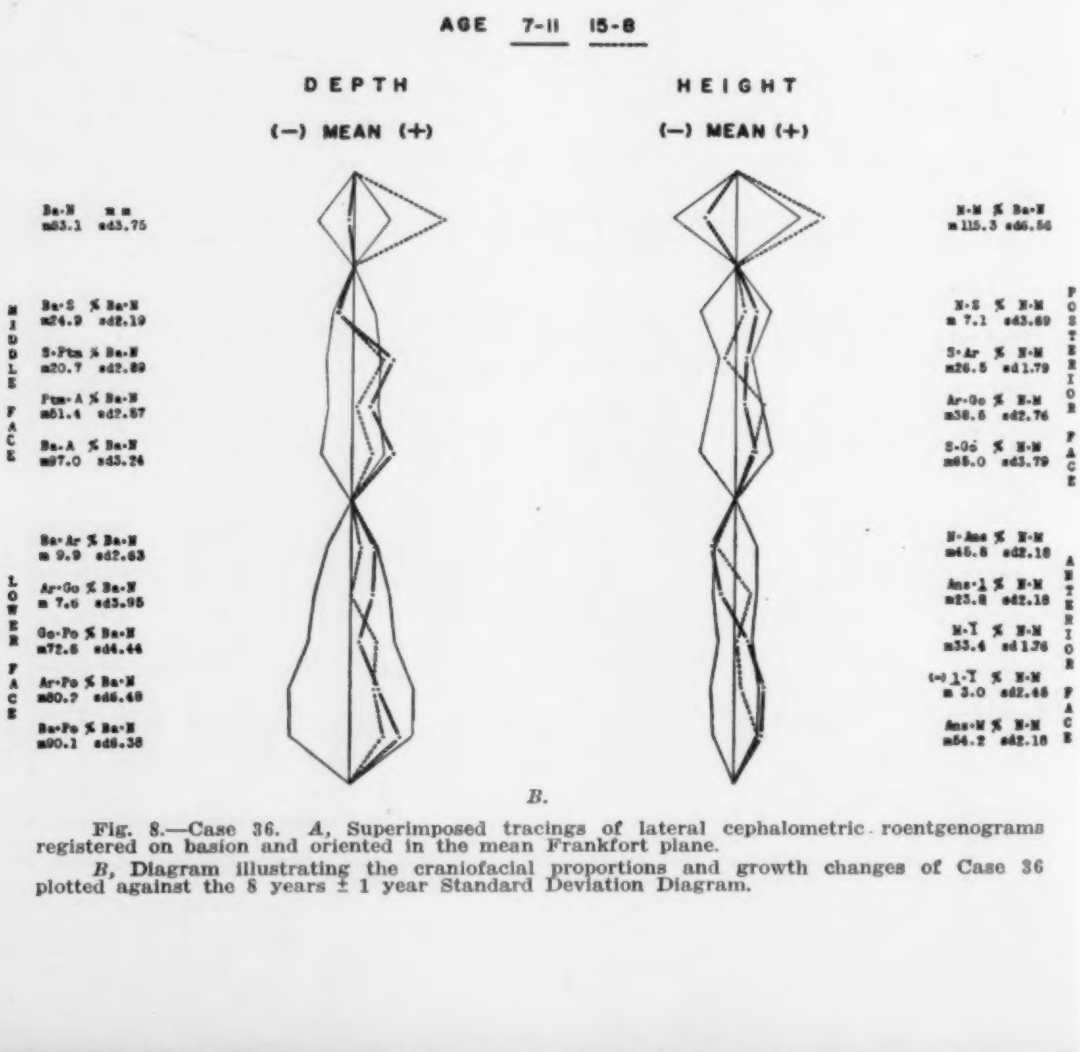
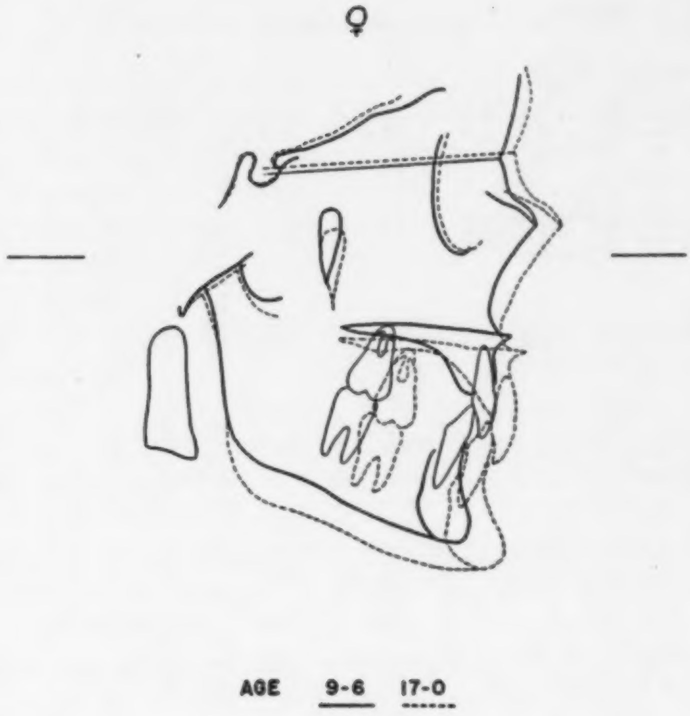


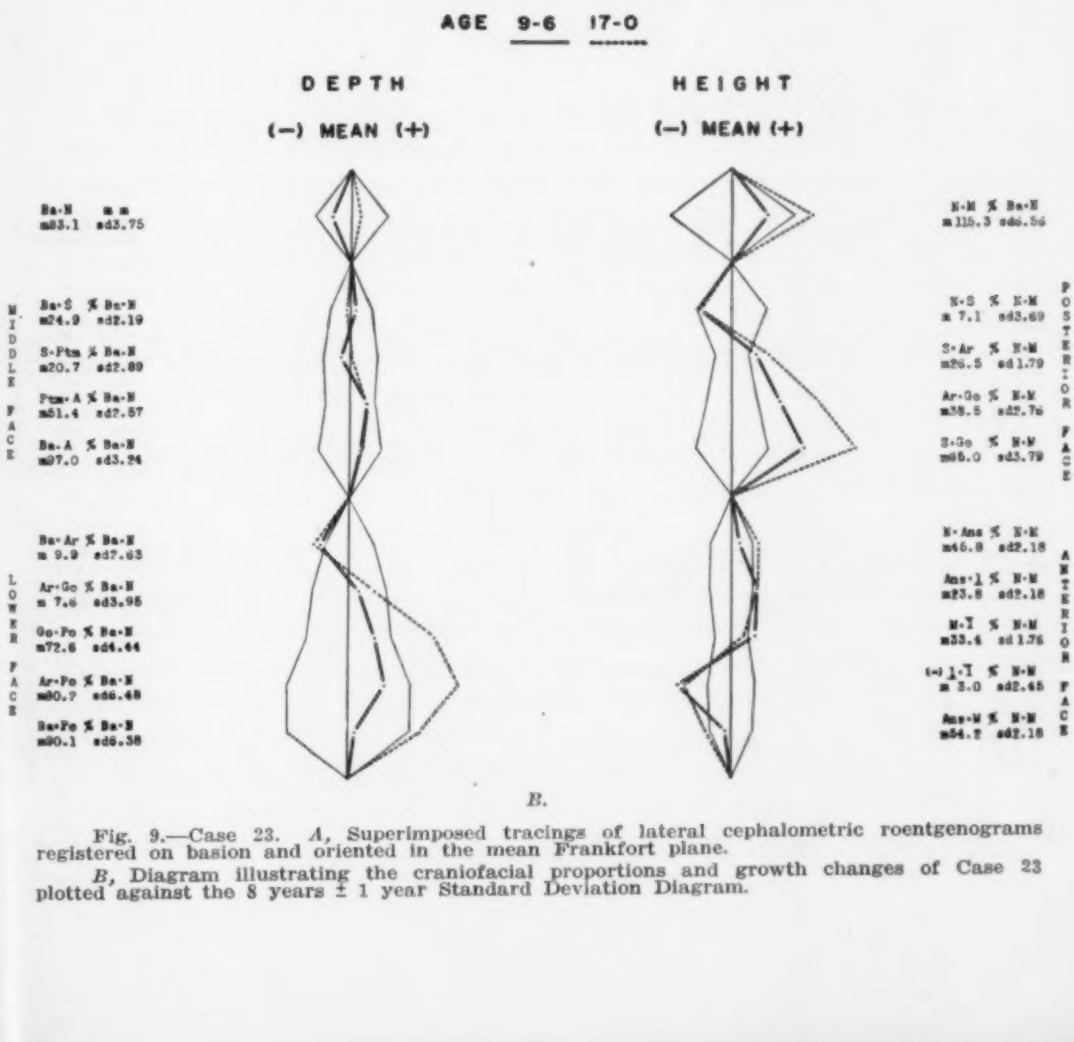
B.

Fig. 8.—Case 36. *A,* Superimposed tracings of lateral cephalometric roentgenograms registered on basion and oriented in the mean Frankfort plane.

B, Diagram illustrating the craniofacial proportions and growth changes of Case 36 plotted against the 8 years ± 1 year Standard Deviation Diagram.



A.



B.

Fig. 9.—Case 23. *A,* Superimposed tracings of lateral cephalometric roentgenograms registered on basion and oriented in the mean Frankfort plane.

B, Diagram illustrating the craniofacial proportions and growth changes of Case 23 plotted against the 8 years ± 1 year Standard Deviation Diagram.

TABLE VII. CASE 23

	SEX: FEMALE	CRANIOFACIAL PROPORTIONS AGE: 9·6				GROWTH INCREMENTS AGE: 9·6 TO 17·0				CHANGES OF CRANIOFACIAL PROPORTIONS AGE: 9·6 TO 17·0			
	MEASUREMENT	UNIT	NO. 23	MEAN	STANDARD DEVIATION	UNIT	NO. 23	MEAN	STANDARD DEVIATION	UNIT	NO. 23	MEAN	STANDARD DEVIATION
	Ba·N	mm	81.0	83.1	3.75	mm	3.0	7.4	2.36	–	–	–	–
	Ba·S	%Ba·N	25.3	24.9	2.19	mm	0.0	3.0	1.57	%Ba·N	-0.9	+1.2	1.22
	S·Ptm	%Ba·N	19.7	20.7	2.82	mm	1.5	1.1	1.30	%Ba·N	+1.1	-0.5	1.66
	Ptm·A	%Ba·N	53.1	51.4	2.59	mm	1.5	4.1	1.39	%Ba·N	-0.1	+0.3	1.32
	Ba·A	%Ba·N	98.1	97.0	3.24	mm	3.0	8.2	2.17	%Ba·N	+0.1	+1.0	1.44
D	Ba·Ar	%Ba·N	6.8	9.9	2.63	mm	-0.5	0.0	1.09	%Ba·N	-0.8	-0.8	1.12
	Ar·Po	%Ba·N	83.9	80.2	6.48	mm	9.0	11.5	3.03	%Ba·N	+7.7	+6.1	3.66
E	Ba·Po	%Ba·N	90.7	90.1	6.38	mm	8.5	11.5	3.01	%Ba·N	+6.9	+5.3	2.97
P	Ar·Go(A.L.)	%Ba·N	52.5	45.2	3.20	mm	7.5	9.1	2.15	%Ba·N	+7.0	+6.4	2.25
	RI ∠	°	10.0	9.8	4.98	°	0.0	-0.7	2.67	°	0.0	-0.7	2.67
T	Ar·Go	%Ba·N	8.6	7.6	3.95	mm	1.5	1.2	2.14	%Ba·N	+1.5	+0.6	2.45
H	Go·Po′(A.L.)	%Ba·N	78.4	76.9	3.99	mm	6.5	9.5	2.58	%Ba·N	+4.9	+4.2	2.71
	MP1 ∠	°	22.0	26.4	4.07	°	-4.0	-4.1	2.16	°	-4.0	-4.1	2.16
	Go·Po	%Ba·N	75.3	72.6	4.44	mm	7.5	10.3	2.71	%Ba·N	+6.2	+5.5	2.84
	Go ∠	°	122.0	126.2	5.41	°	-4.0	-4.8	3.07	°	-4.0	-4.8	3.07
	MP1 ∠(-)	°	22.0	26.4	4.07	°	-4.0	-4.1	2.16	°	-4.0	-4.1	2.16
	RI ∠	°	10.0	9.8	4.98	°	0.0	-0.7	2.67	°	0.0	-0.7	2.67
	N·S	%N·M	3.6	7.1	3.69	mm	0.5	0.6	0.50	%N·M	+0.2	-0.3	0.50
H	S·Ar	%N·M	29.0	26.5	1.79	mm	3.5	2.8	1.45	%N·M	+1.3	-0.1	1.62
	Ar·Go	%N·M	43.5	38.5	2.76	mm	7.5	9.1	2.08	%N·M	+4.1	+4.4	1.51
E	S·Go	%N·M	72.5	65.0	3.79	mm	11.0	11.9	3.17	%N·M	+5.4	+4.3	2.63
I	N·Ans	%N·M	46.6	45.8	2.18	mm	5.5	5.7	2.13	%N·M	+2.0	+0.4	1.81
G	Ans·1	%N·M	26.4	23.8	2.18	mm	2.0	2.6	1.81	%N·M	0.0	-0.1	1.45
	M·1̄	%N·M	35.8	33.4	1.76	mm	1.5	4.4	1.69	%N·M	-1.2	+0.7	1.21
H	1·1̄(-)	%N·M	8.8	3.0	2.45	mm	1.5	1.2	1.45	%N·M	+0.8	+1.0	1.43
T	Ans·M	%N·M	53.4	54.2	2.18	mm	2.0	5.8	2.85	%N·M	-2.0	-0.4	1.81
	N·M	%Ba·N	119.1	115.3	6.56	mm	7.5	11.5	3.14	%Ba·N	+4.7	+3.4	2.72
	Facial ∠	°	85.0	84.8	3.37	–	–	–	–	°	+4.0	+2.8	1.72
	Convexity ∠	°	+6.0	+4.8	4.14	–	–	–	–	°	-7.0	-4.1	3.81

creasing in the male and showing no appreciable change in the female. The female showed little change in the proportion of face height to cranial base depth, while the male face became proportionally longer. In both, the proportion of posterior face height decreased slightly, the inclination of the mandibular plane remaining unchanged in the female and becoming steeper in the male. Although both faces decreased in convexity, the facial angles showed little change.

The variation observed in the growth behavior of the female face represented the combined effect of greater-than-average increment in cranial base depth and less than average increase of posterior face height. The male face, however, showed the resultant effect of less than average growth of the mandibular body associated with below average increment in posterior face height and above average increase in the height of the anterior face.

The facial pattern represented by Fig. 9*A* presented a Class II, Division 2 malocclusion, differing from the Division 1 malocclusions primarily in the size and form of the mandible. The analysis (Table VII and Fig. 9*B*) revealed that the mandible was very characteristic, showing a proportionally larger ramus and body but an acute gonial angle. Although the mandibular contribution to lower face depth exceeded the mean, the effect was diminished by its posterior positioning. The proportion of posterior face height was much greater than average and the lower border of the mandible assumed a more horizontal inclination.

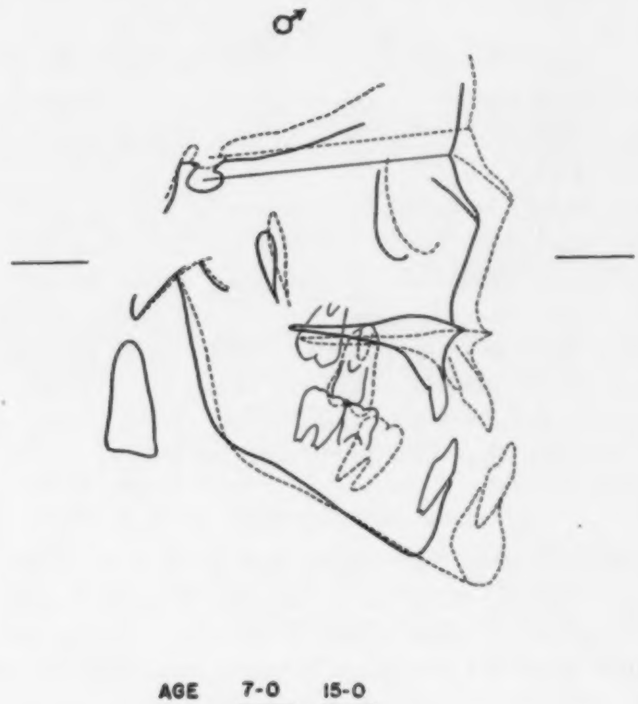
A study of the growth behavior of this face showed that, while the increase of facial depth was below average, the increment of the lower face exceeded that of the upper to produce an increase in lower face prognathism. The vertical growth of the posterior face was close to average, but the increment of the anterior face appeared to be deficient. The resultant effect was an increase in the proportion of posterior face height with a reduction of the mandibular plane angle. The face became proportionally longer, while the facial angle increased and the convexity of the face diminished.

The last case to be presented is a facial pattern exhibiting a Class III malocclusion (Fig. 10*A*). Referring to Table VIII and Fig. 10*B*, it is noted that originally the prognathism of the face was slightly greater than average. The height of the anterior face, relative to depth, was found to be excessive and the lower border of the mandible steeply inclined. The high mandibular plane angle represented the effect of a decreased anterior cranial base height associated with a relatively higher positioning of the mandibular fossa, as suggested by the reduced sella to articulare dimension. Both the mandibular body and the ramus exceeded the mean values, but the increased lower face prognathism was due to the more forward inclination of the ramus, the effect of a greater-than-average gonial angle.

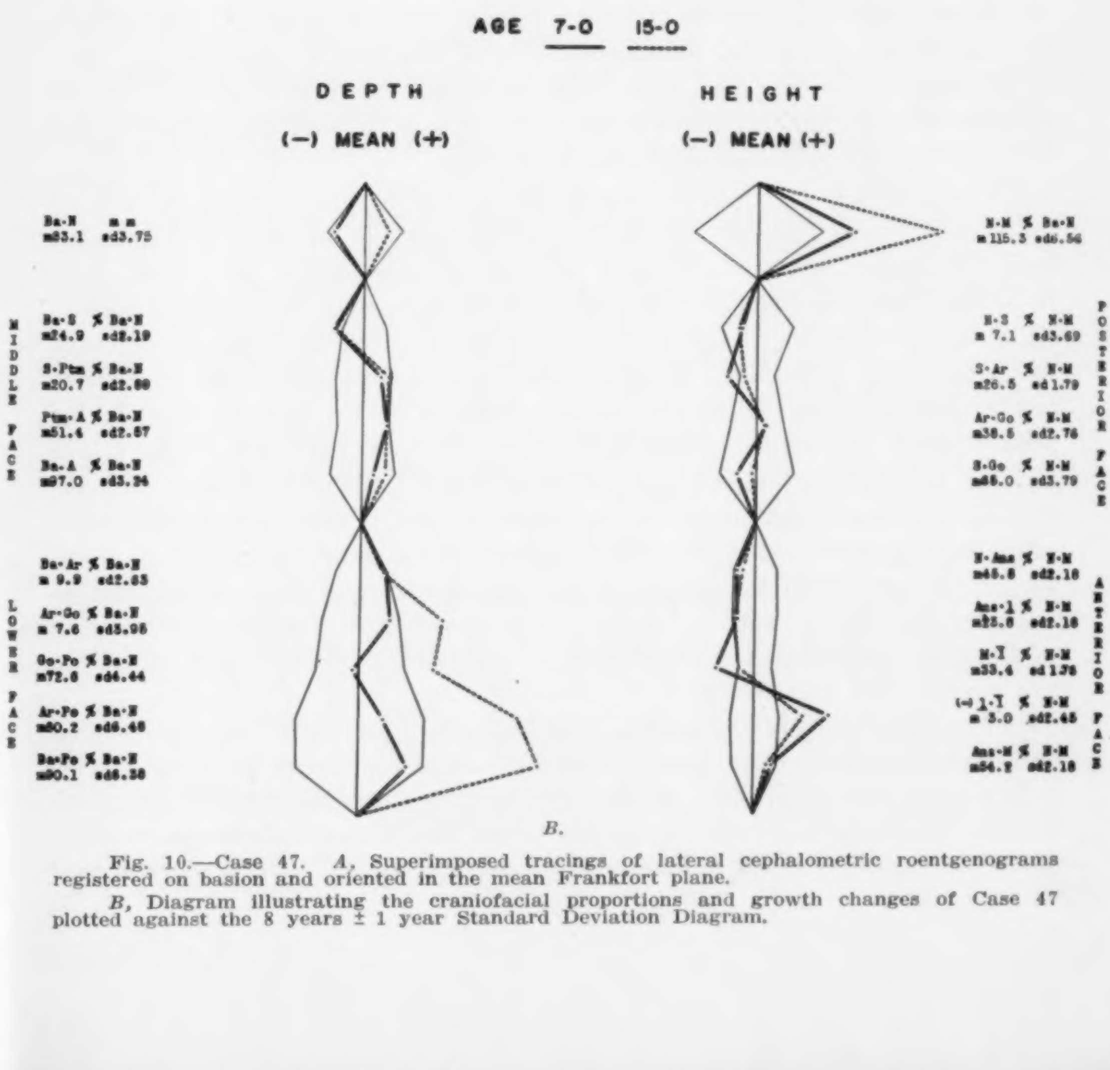
With increase in age, lower face prognathism became excessive, resulting in a marked disharmony of the profile. The most striking finding associated with this behavior was the below-average-depth increment of the cranial base. Al-

TABLE VIII. CASE 47

	SEX: MALE	CRANIOFACIAL PROPORTIONS AGE: 7·0				GROWTH INCREMENTS AGE: 7·0 TO 15·0				CHANGES OF CRANIOFACIAL PROPORTIONS AGE: 7·0 TO 15·0			
	MEASUREMENT	UNIT	NO. 47	MEAN	STANDARD DEVIATION	UNIT	NO. 47	MEAN	STANDARD DEVIATION	UNIT	NO. 47	MEAN	STANDARD DEVIATION
	Ba·N	mm	80.0	83.1	3.75	mm	5.5	9.6	2.14	-	-	-	-
	Ba·S	%Ba·N	21.9	24.9	2.19	mm	1.5	2.8	1.69	%Ba·N	+0.3	+0.5	1.40
	S·Ptm	%Ba·N	22.5	20.7	2.82	mm	2.0	1.6	1.06	%Ba·N	+0.9	-0.5	1.22
	Ptm·A	%Ba·N	53.8	51.4	2.59	mm	3.0	5.5	1.53	%Ba·N	0.0	+0.7	1.82
	Ba·A	%Ba·N	98.2	97.0	3.24		6.5	9.9	2.36	%Ba·N	+1.2	+0.7	1.81
D	Ba·Ar	%Ba·N	12.5	9.9	2.63	mm	0.5	0.0	1.55	%Ba·N	-0.2	-1.1	1.63
E	Ar·Po	%Ba·N	82.5	80.2	6.48	mm	16.0	13.7	4.34	%Ba·N	+13.4	+6.7	4.69
	Ba·Po	%Ba·N	95.0	90.1	6.38	mm	16.5	13.7	4.80	%Ba·N	+13.2	+5.6	4.92
P	Ar·Go(A.L.)	%Ba·N	50.0	45.2	3.20	mm	7.0	11.8	3.21	%Ba·N	+5.5	+7.8	3.31
	RI ∠	°	12.0	9.8	4.98	°	+4.0	-1.3	2.35	°	+4.0	-1.3	2.35
T	Ar·Go	%Ba·N	10.6	7.6	3.95	mm	4.0	0.8	1.69	%Ba·N	+5.3	+0.2	1.77
H	Go·Po′(A.L.)	%Ba·N	78.1	76.9	3.99	mm	11.5	12.5	4.01	%Ba·N	+8.4	+5.8	4.01
	MP1 ∠	°	32.0	26.4	4.07	°	-3.0	-3.3	3.14	°	-3.0	-3.3	3.14
	Go·Po	%Ba·N	71.9	72.6	4.44	mm	12.0	12.9	3.97	%Ba·N	+8.1	+6.5	4.20
	Go ∠	°	134.0	126.2	5.41	°	+1.0	-4.6	3.36	°	+1.0	-4.6	3.36
	MP1 ∠(-)	°	32.0	26.4	4.07	°	-3.0	-3.3	3.14	°	-3.0	-3.3	3.14
	RI ∠	°	12.0	9.8	4.98	°	+4.0	-1.3	2.35	°	+4.0	-1.3	2.35
	N·S	%N·M	5.5	7.1	3.69	mm	0.5	0.9	0.60	%N·M	-0.3	-0.4	0.60
H	S·Ar	%N·M	23.5	26.5	1.79	mm	5.5	5.1	2.10	%N·M	+1.8	0.0	1.84
	Ar·Go	%N·M	39.5	38.5	2.76	mm	5.5	11.6	3.49	%N·M	-0.2	+3.8	2.41
E	S·Go	%N·M	63.0	65.0	3.79	mm	11.0	16.7	3.77	%N·M	+1.6	+3.8	2.40
I	N·Ans	%N·M	44.0	45.8	2.18	mm	7.0	9.0	3.14	%N·M	+0.5	+0.2	2.18
G	Ans·1	%N·M	22.0	23.8	2.18	mm	3.0	3.8	2.31	%N·M	-0.2	-0.6	1.58
	M·$\bar{1}$	%N·M	29.5	33.4	1.76	mm	6.0	7.1	2.28	%N·M	+2.3	+0.7	1.68
H	1·$\bar{1}$(-)	%N·M	-4.5	3.0	2.45	mm	+1.5	0.8	1.87	%N·M	+2.6	+0.3	1.99
T	Ans·M	%N·M	56.0	54.2	2.18	mm	7.5	10.1	3.73	%N·M	-0.5	-0.2	2.18
	N·M	%Ba·N	125.0	115.3	6.56	mm	14.5	19.1	5.04	%Ba·N	+8.9	+8.6	4.85
	Facial ∠	°	87.0	84.8	3.37	-	-	-	-	°	+7.0	+3.0	2.44
	Convexity ∠	°	+2.0	+4.8	4.14	-	-	-	-	°	-11.0	-4.7	4.10



A.



B.

Fig. 10.—Case 47. *A*, Superimposed tracings of lateral cephalometric roentgenograms registered on basion and oriented in the mean Frankfort plane.

B, Diagram illustrating the craniofacial proportions and growth changes of Case 47 plotted against the 8 years ± 1 year Standard Deviation Diagram.

though the absolute increment of the posterior cranial base was close to the mean, the vertical direction of its growth contributed chiefly to face height and little to face depth.

On the other hand, the lower face increment slightly exceeded the mean, even though the growth of the ramus and the body was actually less than average. The decrease in the mandibular plane angle, associated with an abnormal increase in the gonial angle, inclined the ramus further forward to produce a greater than average effective increment in the lower face. This failure of change of the directional growth of the condyle, associated with the vertical direction of the growth of the posterior cranial base, appeared to be the significant factor in the production of this disharmony.

DISCUSSION

From a study of human facial form and growth, one cannot help but be impressed with the infinite variation in the size, form, and growth of all structures. To comprehend variation of facial types and differences in the growth behavior of faces, it is not sufficient to study any single variant alone, for the significance of each characteristic lies in its integration in the total facial morphology.

No characteristic can be judged "normal" or "abnormal," harmonious or unharmonious, without an appreciation of the role it plays in the total facial complex. What may seem to be a harmoniously formed mandible in one face may be unharmonious in another. A steep mandibular plane in one face may be a harmonious adaptation in another.

Variation has been shown repeatedly in the morphology and growth of the mandible and maxilla, but little has been said of the role of the cranial base. Although anatomically it is convenient to separate the cranial base from the dentofacial complex, in reality there is no such division. Abnormal variation in the configuration and growth behavior of the cranial base may result in severe dentofacial disharmonies. A severe flexure of the base without a corresponding reduction in the mandible might lead to mandibular prognathism. An obtuse cranial base may so increase the depth of the upper face as to result in mandibular retrusion. A relatively horizontal anterior cranial base may position the entire posterior face at such a high level as to effect an abnormally steep mandibular plane and mandibular retrusion. Conversely, a very steep inclination of the anterior cranial base might position the posterior face to such a low level as to result in a horizontal inclination of the mandibular plane. Any and all combinations and degrees of variations are possible and do exist.

The importance of the cranial base in facial growth also has not received sufficient attention. The superimposed tracings registered on basion, with sella-nasion planes parallel, graphically illustrate the mechanism by which growth of the cranial base carries the upper face forward and upward away from the vertebral column, leaving the mandible behind. Differences appear

to exist not only in the absolute increment of the posterior cranial base, but also in its directional growth, contributing more to facial depth in one person and more to height in another.

Surprisingly little change was noted in the basion-articulare dimension in the cases studied. This finding strongly suggests that the position of the mandibular fossa relative to basion changes little, if at all. Mandibular increment must keep pace with the growth of the base of the cranium if there is to be a harmonious relationship in the dentofacial complex.

When one considers the contribution of the mandible to the growth of the face, it is not sufficient to study the growth of the mandibular body or ramus alone. In each of the cases presented, attention has been drawn to the effect of the change in the position of the lower border of the mandible, to the change in the directional growth of the condyle, and to the resultant effect of the inclination of the ramus in the pattern. In the study of facial growth one must consider not only the absolute increments of parts, but also the directional growth of structures which may determine the effectiveness of their contributions.

From the analysis of individual patterns, it appears that a broader outlook upon the etiology of malocclusion is also warranted. All Class II and Class III malocclusions cannot be explained on the basis of a small or large mandible. Although statistics may point to one or more areas of abnormality, the individual may present any one of many combinations of disharmony. When one considers the variation seen in the cranial base and the variation in every structure composing the dentofacial complex, it would seem that there could not be any rigid combination of factors associated with any particular type of malocclusion. The adjustments and combinations are infinite and it is the integration of these variables which determines harmony or disharmony.

Generalities in growth behavior have been presented and offer valuable guides in the prognosis of the path of facial development of the majority of persons, but it must be emphasized that the numbers of faces that deviate from these generalities are many. No characteristic, or combination of characteristics, yields an infallible formula to the growth potential of the individual face.

REFERENCES

1. Broadbent, B. H.: A New X-ray Technique and Its Application to Orthodontia, Angle Orthodontist **1**: 45-66, 1931.
2. Broadbent, B. H.: The Face of the Normal Child, Angle Orthodontist **7**: 183-208, 1937.
3. Brodie, A. G.: On the Growth Pattern of the Human Head From the Third Month to the Eighth Year of Life, Am. J. Anat. **68**: 209-261, 1941.
4. Björk, A.: The Face in Profile. An Anthropological X-ray Investigation on Swedish Children and Conscripts, Svenska Tandl. Tiddsskrift **40**: No. 5B, Supp. Lund, 1947.
5. Lande, M. J.: Growth Behavior of the Human Bony Facial Profile as Revealed by Serial Cephalometric Roentgenology, M. S. thesis, University of Illinois, 1951.
6. Adams, J. W.: Cephalometric Studies on the Form of the Human Mandible, M. S. thesis, University of Illinois, 1939.
7. Elman, E. S.: Studies on the Relation of the Lower Six-Year Molar to the Mandible, Angle Orthodontist **10**: 24-32, 1940.

8. Baldridge, J. P.: A Study of the Relation of the Maxillary First Permanent Molars to the Face in Class I and Class II Malocclusions, Angle Orthodontist **11**: 100-109, 1941.
9. Wylie, W. L.: A Quantitative Method for the Comparison of Craniofacial Patterns in Different Individuals: Its Application to a Study of Parents and Offspring, Am. J. Anat. **74**: 39-60, 1944.
10. Renfroe, E. W.: A Study of the Facial Patterns Associated With Class I, Class II, Division 1, and Class II, Division 2 Malocclusions, Angle Orthodontist **18**: 12-15, 1948.
11. Shoenwetter, R. F.: The Relation of the Upper and Lower First Permanent Molars to the Face in Class III Malocclusion, Angle Orthodontist **18**: 16-19, 1948.
12. Staph, W. C.: A Cephalometric Roentgenographic Appraisal of the Facial Pattern in Class III Malocclusions, Angle Orthodontist **18**: 20-23, 1948.
13. Drelich, R. C.: A Cephalometric Study of Untreated Class II, Division 1 Malocclusion, Angle Orthodontist **18**: 70-75, 1948.
14. Elsasser, W. A., and Wylie, W. L.: The Craniofacial Morphology of Mandibular Retrusion, Am. J. Phys. Anthropol. **6**: 461-473, 1948.
15. Riedel, R. A.: A Cephalometric Roentgenographic Study of the Relation of the Maxilla and Associated Parts to the Cranial Base in Normal and Malocclusion of the Teeth, M. S. D. thesis, Northwestern School of Dentistry, 1948.
16. Craig, C. E.: The Skeletal Patterns Characteristic of Class I and Class II, Division 1 Malocclusions (Angle) in Norma Lateralis, M. S. thesis, University of Illinois, 1950.
17. Gilmour, W. A.: Morphology of the Adult Mandible in Class II, Division 1 Malocclusion and in Excellent Occlusion, Angle Orthodontist **20**: 137-146, 1950.
18. Blair, E. S.: A Cephalometric Roentgenographic Appraisal of the Skeletal Morphology of Class I, Class II, Division 1, and Class II, Division 2 (Angle) Malocclusions, M. S. thesis, University of Illinois, 1952.
19. Sanborn, R. T.: Differences Between the Facial Skeletal Patterns of Class III Malocclusion and Normal Occlusion, M. S. thesis, University of Illinois, 1952.
20. Hellman, M.: Some Biologic Aspects: Their Implications and Application in Orthodontic Practice, INT. J. ORTHODONTIA **23**: 761-785, 1937.
21. Downs, W. B.: Variations in Facial Relationships: Their Significance in Treatment and Prognosis, AM. J. ORTHODONTICS **34**: 812-840, 1948.
22. Wylie, W. L.: An Assessment of Anteroposterior Dysplasia, Angle Orthodontist **17**: 97-109, 1947.
23. Brodie, A. G.: Facial Patterns—a Theme on Variation, Angle Orthodontist **16**: 75-88, 1946.
24. Adams, J. W.: Correction of Error in Cephalometric Roentgenograms, Angle Orthodontist **10**: 3-13, 1940.

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ABNORMAL FUNCTION OF THE TEMPOROMANDIBULAR JOINT

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THE responsibilities of the orthodontist lie in the establishment of correct function and the creation of a permanent result. In this regard, a consideration of the health of the temporomandibular joint is an absolute necessity. This is due to the fact that joint pathology, in a majority of cases, is directly or indirectly the result of malocclusion. Therefore, the orthodontist is in a position to diagnose conditions in the child that may contribute to joint disease in the adult.

The x-ray has proved to be a valuable tool for the diagnosis of temporomandibular joint disturbances, but in order to properly interpret the radiographic film, the characteristics of the normal must first be known. A standard or a yardstick must be available in order to evaluate the abnormal.

DESCRIPTION OF THE NORMAL

Both joints of fifty persons with no clinical manifestations of joint disorders were studied in order to provide an acceptable description of the normal. Fig. 1 represents three cases which portray the ideal or average conditions. Two common characteristics will be noted in all three examples: first, the condyle is located in a well-centered position in the fossa and, second, the articular surfaces are smooth.

The condyle position was measured and calculated at three sites (Fig. 1). The average distance from the anterior surface to the eminence was 1.5 mm. The mean dimension from the top of the condyle to the floor of the fossa was 2.5 mm., and the average condyle was located 7.5 mm. anterior to the center of the external auditory canal.

This might be considered a description of perfect temporomandibular articulations. If these relationships could be accepted as the standard, diagnosis of abnormal conditions would be a simple matter. However, this is not the manner in which Nature always works. Fig. 2 represents the differences in the joints of naturally occurring cases. When the total natural variation is employed for comparison, the average figures have little value.

Several factors should be considered in evaluating the variations in the anatomy of the joint. First, there is no consistent harmony in *size* of the articulating bodies. In Fig. 2, the examples in the upper left and lower left illustrate this point. The upper tracing demonstrates a small condyle head, while in the lower the condyle appears too large for its fossa. Second, the *form*

Presented as part of temporomandibular joint symposium before the American Association of Orthodontics in Chicago, May, 1954.

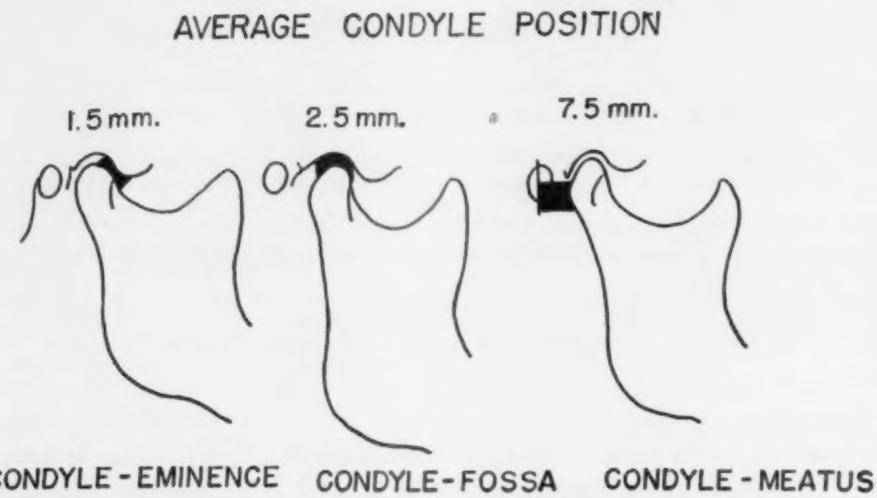

Fig. 1.—Tracing of three laminagraph sections picked from sample of 100 cases to demonstrate ideal condyle-fossa relationship. Note two common characteristics—well-centered condyle and smooth articular surfaces. Left figure represents average condyle-eminence dimension; middle represents average condyle-fossa dimension. Right figure demonstrates average distance from condyle to a line through center of external auditory canal.

Comparison to strict "perfect" relationship demonstrated here would be simple. However, range of natural variation (Fig. 2) must be the proper yardstick for comparison of the abnormal.

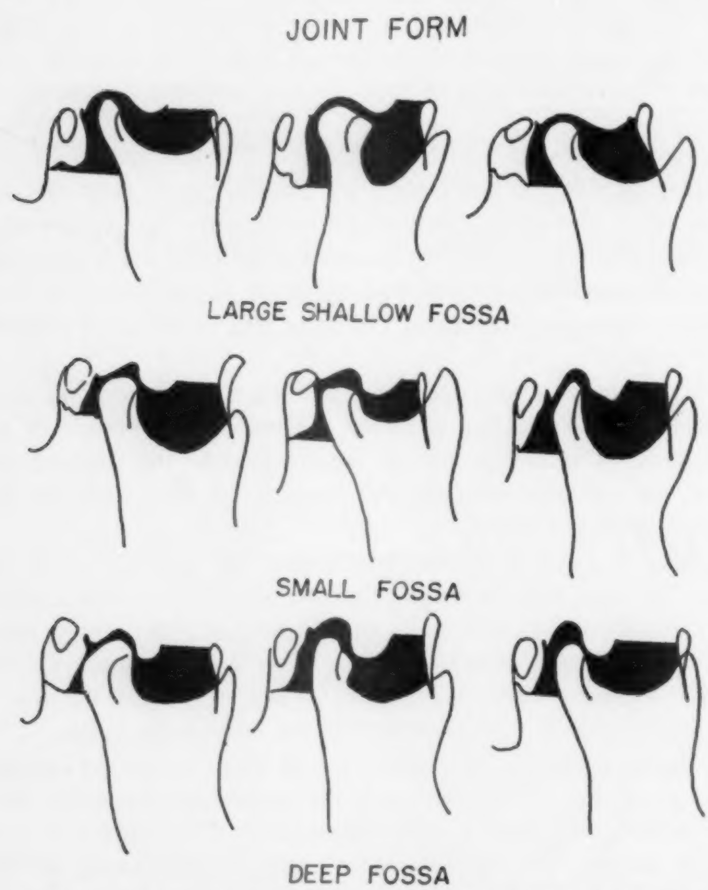

Fig. 2.—Variation in human temporomandibular joints. Three things account for difference in these joints: (1) no harmony in size of condyle and fossa (upper and lower left); (2) little consistency of the form of articulating bodies (left center and upper right); (3) variation in condyle position (note lower right). Natural functional adaptation also must be considered in determining abnormal joints. Note suggested adaptation on condyle in center figure and on eminence in right center figure.

of the mandibular condyle head may be entirely dissimilar to the form of the temporal portion of the joint (note Fig. 2, center figure in particular). Third, the condyle may be *positioned* either deep in the fossa or rather forward and downward in the fossa, as seen in the lower right tracing of Fig. 2. Thus, shallow fossae, small fossae, or deep fossae appear to be independent variables with the condyle head. However, functional adaptation is suggested in some instances, but serial studies would be needed to prove this occurrence (Fig. 2, center and right center cases).

PATHOLOGY

The wide range of variation almost dispelled any hope of employing a standard for comparison of the abnormal. However, variation in excess of that considered normal was observed frequently enough to warrant the acceptance of a standard range for the evaluation of the pathologic case.

The following cases were selected from a sample of 200 cases. They were chosen to demonstrate four specific types of joint disturbances caused by conditions of occlusion of the teeth.

TYPE 1, EXCESSIVE FUNCTION (FIG. 3)

The etiology in this type is excessive range of function and abnormal functional position of the condyle. This particular condition is characteristic of Class II, Division 1 type malocclusion cases. In the Class II condition, the patient thrusts the mandible forward as much as five times the normal distance in order to incise food (Fig. 3, upper right). In addition, dual bite cases sometimes masticate in the anterior position. Habitual activity in the anterior position apparently wears the articular disc and eventually the surface of the condyle and eminence. In involved cases, even speaking aggravates the pain and discomfort of the joints. Two such cases encountered were treated orthodontic cases in which a guide had been employed to position the mandible forward. Attempts to heedlessly jump the bite are not consistent, therefore, with an appreciation of the health of the joint structures, especially if no condyle growth remains to aid in the necessary adjustments of the muscles, teeth, and mandible. Advanced pathologic conditions are represented in Cases P63 and P198 in Fig. 3. Case P63 had been injected with sclerosing agents on six occasions.

The physiologic rest position changes during treatment in such cases because the mandible is abnormally downward and forward before treatment. The treatment for joint conditions of this nature is correction of the overjet and reduction of the range of activity for normal and necessary movements. This permits a rehabilitation of the musculature to a balanced condyle relationship (Case P124, Fig. 3). Orthodontic intervention is the method of choice. Removal of anterior teeth and fixed or partial bridgework have also proved effective.

TYPE 2, DISTAL DISPLACEMENT (FIG. 4)

This type is found quite frequently, but not always, in Class II, Division 2 types of malocclusion. It is characterized by the deep overbite, retruded

anterior teeth, and distal path of closure from rest position. The mandible is usually driven posteriorly into the fossa by incision of the anterior teeth (Case P78, Fig. 4). The ligaments do not permanently withstand the prolonged stretching, as reciprocal innervation produces an inhibition of external pterygoid activity, thereby permitting a retrusion of the condyle head.

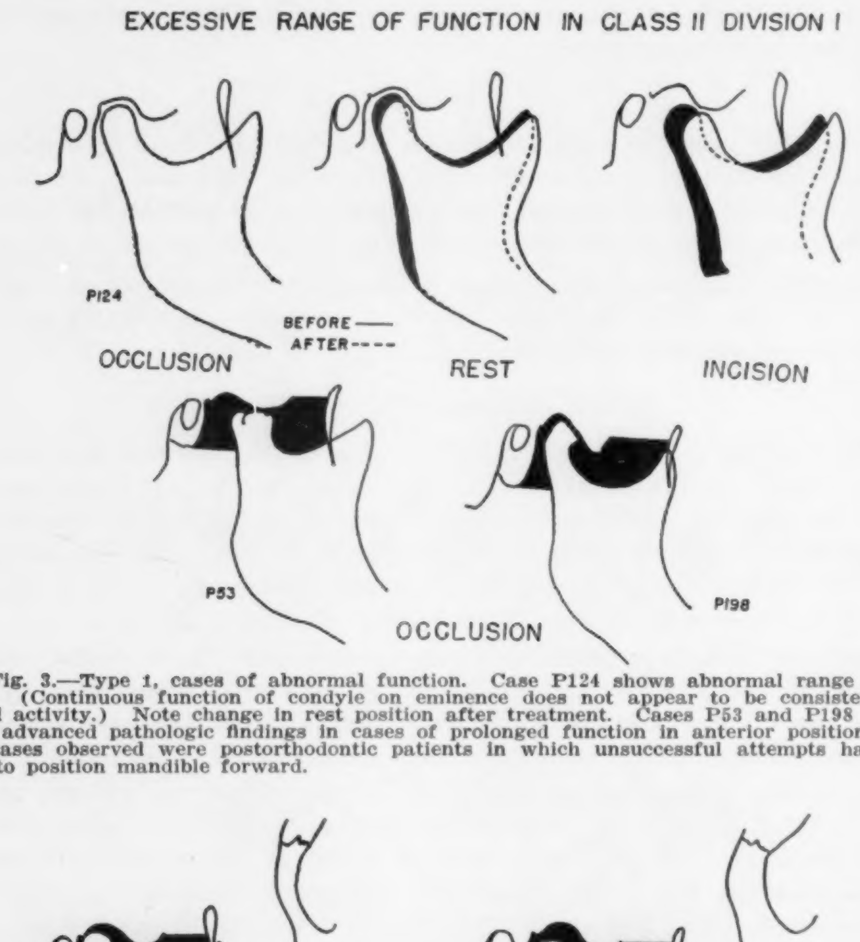

Fig. 3.—Type 1, cases of abnormal function. Case P124 shows abnormal range for incision. (Continuous function of condyle on eminence does not appear to be consistent with normal activity.) Note change in rest position after treatment. Cases P53 and P198 demonstrate advanced pathologic findings in cases of prolonged function in anterior position. Two such cases observed were postorthodontic patients in which unsuccessful attempts had been made to position mandible forward.

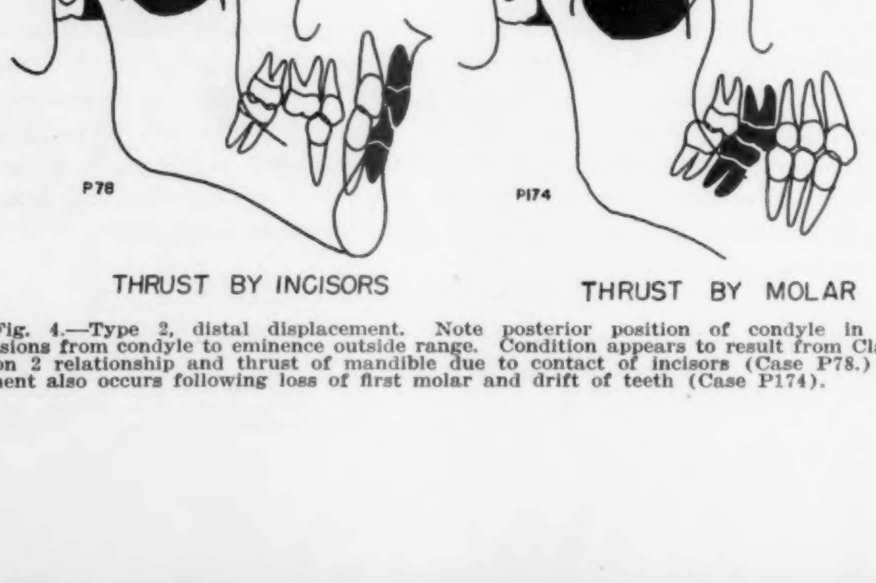

Fig. 4.—Type 2, distal displacement. Note posterior position of condyle in fossa. Dimensions from condyle to eminence outside range. Condition appears to result from Class II, Division 2 relationship and thrust of mandible due to contact of incisors (Case P78.) Displacement also occurs following loss of first molar and drift of teeth (Case P174).

The etiology of this condition is not limited to the anterior teeth. Loss of the lower first molar, shifting of remaining molar teeth forward, even maintaining the same occlusion, will wedge the condyle deeper into the fossa (Case P174, Fig. 4). This is a slow process and requires time to develop.

Slight bite-opening merely to remove the influence of the teeth usually will yield dramatic results. An overlay acrylic splint on the upper arch is the usual method of choice.

TYPE 3, INTERFERENCE (FIG. 5)

This type is characterized by molar interference during chewing and incising. A common feature in this type is the missing upper third molar and exfoliation of the lower third molar (Case P32, Fig. 5). Under normal circumstances, condyle action against the eminence forces the rows of teeth apart in

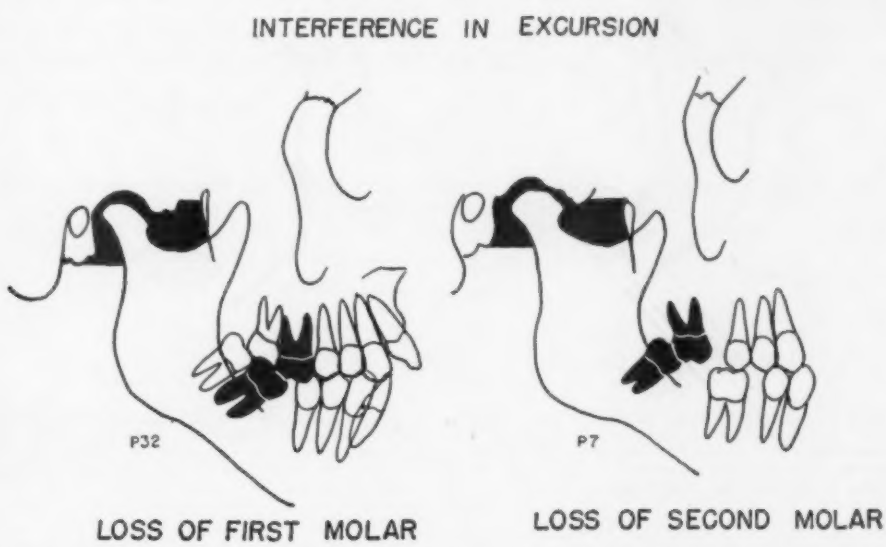

Fig. 5.—Type 3, occlusal interference. Note severe breakdown of both condyle and eminence, apparently resulting from trauma. In Class II cases loss of lower first molar and upper third molar (Case P32) permits elongation of lower third molar past normal line of occlusion. Molar there interferes with condyle action on eminence and lever action of muscles disarticulates joint. The same traumatic condition can be set up in normal arch relationship as upper molar exfoliates into space created by loss of lower molars (Case P7).

the posterior area. However, the supraerupted lower molar contacts the upper teeth and upsets the normal proprioceptive influence provided by the teeth. The muscle pattern becomes confused or imbalanced, and tramatic conditions of both teeth and muscle contribute to the joint involvement. These cases can be caused by the first molars and sometimes even the premolars. Cross-bites frequently behave in a similar manner, especially when occurring unilaterally.

The treatment for this condition usually consists of removing the interfering tooth structure. The occlusal plane can be leveled to promote smooth excursion. The preferred conservative method, however, is an acrylic splint built up in the area of the cuspid to initiate normal reflex activity of the musculature.

TYPE 4, LOSS OF POSTERIOR SUPPORT (FIG. 6)

This type is also displacement, but in mesial or superior, rather than distal, direction. In the absence of posterior teeth, the anterior teeth are usually used exclusively for chewing. In mesial thrust, the external pterygoid is often in a state of contracture and maintains the condyle against the eminence (Case P107, Fig. 6). Forces usually borne by the teeth are therefore transferred through the joint. It should be pointed out again that it is the damaging effect of musculature in these instances, as well as all the others, that is the final etiological factor.

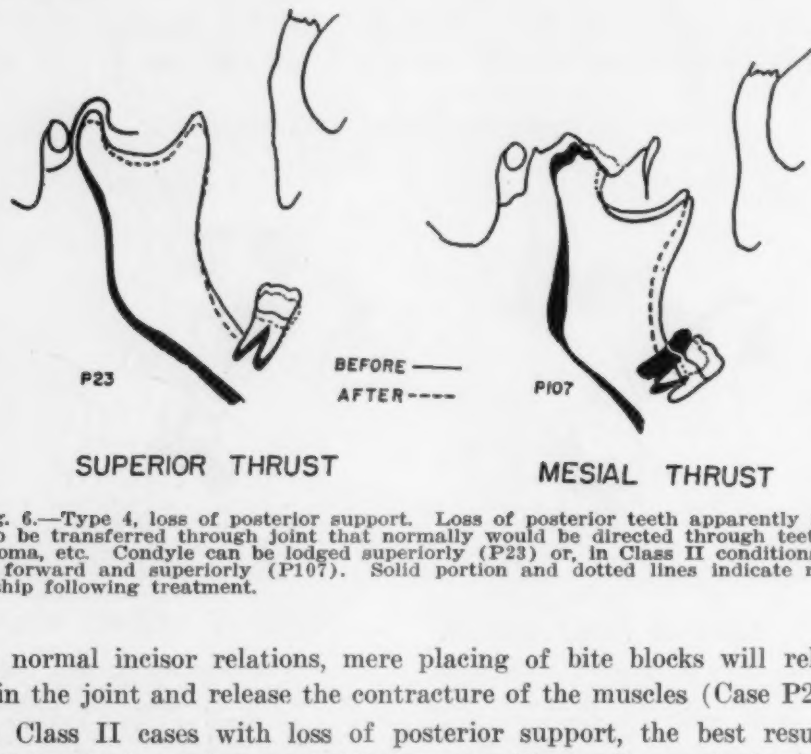

Fig. 6.—Type 4, loss of posterior support. Loss of posterior teeth apparently may cause forces to be transferred through joint that normally would be directed through teeth, maxilla and zygoma, etc. Condyle can be lodged superiorly (P23) or, in Class II conditions, it might be held forward and superiorly (P107). Solid portion and dotted lines indicate mandibular relationship following treatment.

In normal incisor relations, mere placing of bite blocks will relieve the strain in the joint and release the contracture of the muscles (Case P23).

In Class II cases with loss of posterior support, the best results were achieved by placing a lower partial denture with acrylic overlaying the lower anterior teeth. This, in effect, relieved the necessity of excessive forward thrust to incise, as well as providing cuspid activity for smooth lateral excursion.

SUMMARY AND CRITICAL OBSERVATIONS

In the analysis of any temporomandibular joint case, systemic factors should be recognized. General health was considered, especially in those patients experiencing pain in other joints. Psychologic factors were observed to be important. Anxieties and tensions were thought to promote bruxism and lead to joint involvement. However, occlusal disharmony should be ruled out as an etiological factor before radical treatment is resorted to in all temporomandibular joint cases.

Certain ideas seem pertinent to a consideration of abnormal function of the jaw joint:

1. Occlusion is the basis for joint disturbance in a majority of cases. Our experience permits a classification of four distinct conditions or types of etiological factors, which are: Type 1, excessive function; Type 2, distal displacement; Type 3, interference; and Type 4, loss of posterior support.

2. Musculature, in the final analysis, is the structure treated in the correction of joint disturbance. It is the damaging effect of musculature that produces trauma to the joint surfaces.

3. In addition to considering the development of occlusion, the clinician should apply general orthopedic concepts to joint analysis. This includes the role of stabilization of musculature and the synchronization of muscle activity through the nervous system.

4. It is up to you, as orthodontists, to prevent temporomandibular joint disease. Proper service can be rendered by harmonizing the denture with joint structures and muscles, so have respect for the joint. It can be more important than you think.

REFERENCES

1. Ricketts, R. M.: Variations of the Temporomandibular Joint as Revealed by Cephalometric Laminagraphy, AM. J. ORTHODONTICS 36: 877-898, 1950.
2. Ricketts, R. M.: Laminagraphy and the Diagnosis of Temporomandibular Joint Disorders, J. Am. Dent. A. 46: 620-648, 1952.

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ANALYSIS OF ORTHODONTIC DEFORMITY EMPLOYING LATERAL CEPHALOSTATIC RADIOGRAPHY

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INTRODUCTION

CEPHALOMETRICS has proved a valuable tool in the gross study of growth and treatment changes in the hard tissues. However, our use of cephalometrics in assessing the anatomic pattern of the child and relating this pattern to the formulation of a prognosis and treatment plan still rests largely in the field on conjecture.

To start at fundamentals, our aim in orthodontics is to create beauty. Our concept of beauty rests largely on harmony of anatomic relations. This harmony gives good esthetics and function.

In viewing a child, we visually compare the child with an average and a range called normal. Variation within normal range is harmonious and interesting, but variation outside normal range is incongruous and ugly.

Creation of beauty in our patients is, then, a modification of anatomy to a more harmonious pattern. Modifiable features are altered to conform more harmoniously with nonmodifiable features. Thus, clinical cephalometrics is required to tell us more than just the anatomic pattern displayed by a child; we also wish to know in what manner anatomic features of a modifiable nature may be harmoniously related to nonmodifiable anatomic features. The method that I am presenting of assessing the lateral cephalogram has received clinical testing over some years and, to a certain extent, satisfies these criteria. Data are derived from six groups of normal persons, with thirty in each group at the ages of 3, 6, 8, 10, 12, and 22 years, respectively, and from three groups of abnormal persons.

We may view the skull on a lateral cephalogram as displaying three functional areas:

1. The masticatory area, including the jaws and teeth. The functional plane of this area is the occlusal plane.

2. The cranial area supported on its functional plane, the cranial base. Here this plane is represented by Broadbent's[5] Bolton plane. Point basion lies 1 to 2 degrees below Bolton plane measured from nasion.

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3. A nasal orbital area lying between the cranial and masticatory areas.

The fifth nerve musculature has its origin in the cranial area and attachment in the masticatory area. Thus, the masticatory area and its orientation to the cranial area are of major interest in our field.

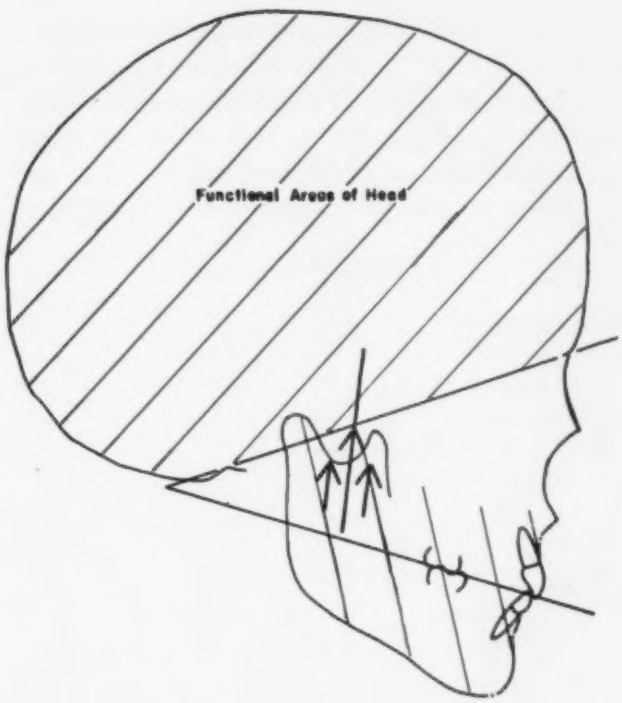

Fig. 1.—Functional areas of head.

MASTICATORY AREA

It is in the masticatory area that the main orthodontic deformity is manifest. The functional plane of the masticatory area is the occlusal plane. Thus, from a functional viewpoint, the occlusal plane is a most desirable reference plane. Briefly, its advantages may be summarized as follows:

1. All phases of dentistry have traditionally used this reference plane, and a great deal of our thinking is oriented about it.

2. The resultants of all the components of force in the masticatory area are expressed about the occlusal plane. Thus, its behavior reflects the sum of all the influences acting on this area.

3. Since the teeth form the occlusal plane, this is the only plane to which the teeth of each jaw are intimately related.

4. The occlusal plane is the plane of reference of the Angle[1] classification and Baume's[2] classification.

Disadvantages of this plane are:

1. Normally, it is not a plane, but a complex curve.

2. Abnormally, it is very difficult to define.

3. In any case, it cannot be reliably drawn and a tracing cannot be reliably repeated.

The occlusal plane used in this study is the average occlusal plane of the buccal teeth, including canine and first permanent molar.

A study of occlusal plane position indicates that this is primarily determined by the vertical orientation of maxillae and mandible. Some complex statistics suggest that the angulation of this plane, as determined by skeletal influences, has a mean position 3 degrees above the Frankfort-mandibular angle bisector. Owing to the unreliability of the cephalometric Frankfort

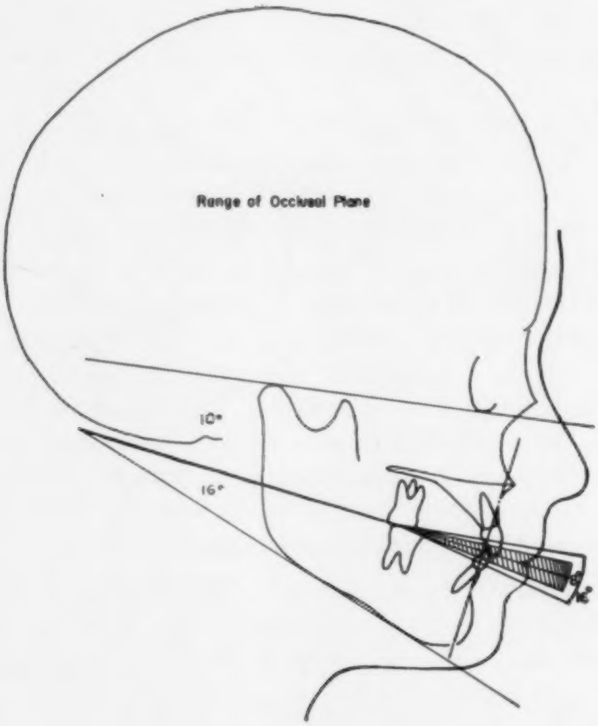

Fig. 2.—A sample showing a range of 16 degrees for Frankfort-mandibular angle, with a range of only 8 degrees for the Frankfort-occlusal angle.

plane, a line through orbitale and the floor of the temporomandibular fossa, is used to represent Frankfort plane. As shown on Fig. 2, the occlusal plane is more closely related to the Frankfort-mandibular angle bisector than either the Frankfort or mandibular plane. The bony jaws represent approximately one-half the influences determining occlusal plane position in normal persons. When the posterior teeth (deciduous or permanent) first erupt, they normally erupt to establish their occlusal plane well identified with our predetermined

plane derived from skeletal measurements. Local phenomena, such as individual tooth eruption pattern and anteroposterior jaw relations, may cause a few degrees' difference between these skeletal and dental planes. Thus, the occlusal plane of the deciduous molars and the permanent premolars and first permanent molars closely identifies itself with our skeletally calculated reference plane. The incisors display more variability, although Class II, Division 1 maxillary incisors tend to contact this plane occlusally, in agreement with the findings of Prakash and Margolis.[10]

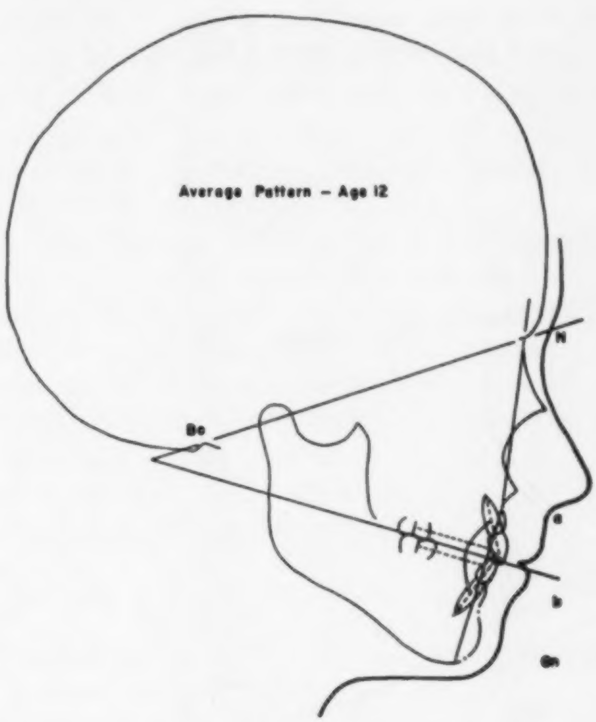

Fig. 3.—Planes used in lateral headplate analysis.

This skeletally determined occlusal reference plane is thus a useful plane from which to study the masticatory area and its variation and cranial orientation, for this plane is not only reliably retraced, but it is independent of local oral disturbances. In the study of treatment changes, it may be maintained constant at its original angle with Bolton plane, an artifice employed by Broadbent[5] in his serial study to avoid using the unreliable cephalostatic Frankfort plane. Further, in orthodontics and prosthesis, a skeletally determined plane provides a plane to which the teeth may be set in harmony with skeletal environment.

In this study jaw relations measured about the occlusal reference plane agree with descriptions by Howes,[8] Brodie,[6] and Lande.[9]

In Fig. 3, *a* plane is drawn at right angles to the occlusal plane, and *b* point, gnathion point (derived from a line drawn at 45 degrees to the mandibular

plane and tangent to the bony chin), and incisor and molar relations were studied. Gnathion value resembles the end product of a Wylie analysis. Discussing the mean values, *b, Gn,* and mandibular incisor edge favorably are forward of *a* plane at all ages and, by 8 years of age, to the extent of 2 mm. By the age of 12 years, the mandible is forward of the maxilla by 2 to 3 mm. This jaw relation establishes neutroclusion. The molars, second deciduous and first permanent, are placed equidistant posteriorly from *a* and *b* points, respectively, measured along occlusal plane. In the study of growth changes, general growth is studied by superimposition on references Bolton plane and *R* point. On the other hand, mandibular growth is studied by superimposition on references occlusal plane and *a* point. The occlusal plane is held at a constant angle to Bolton plane and drawn through the posterior occlusal area.

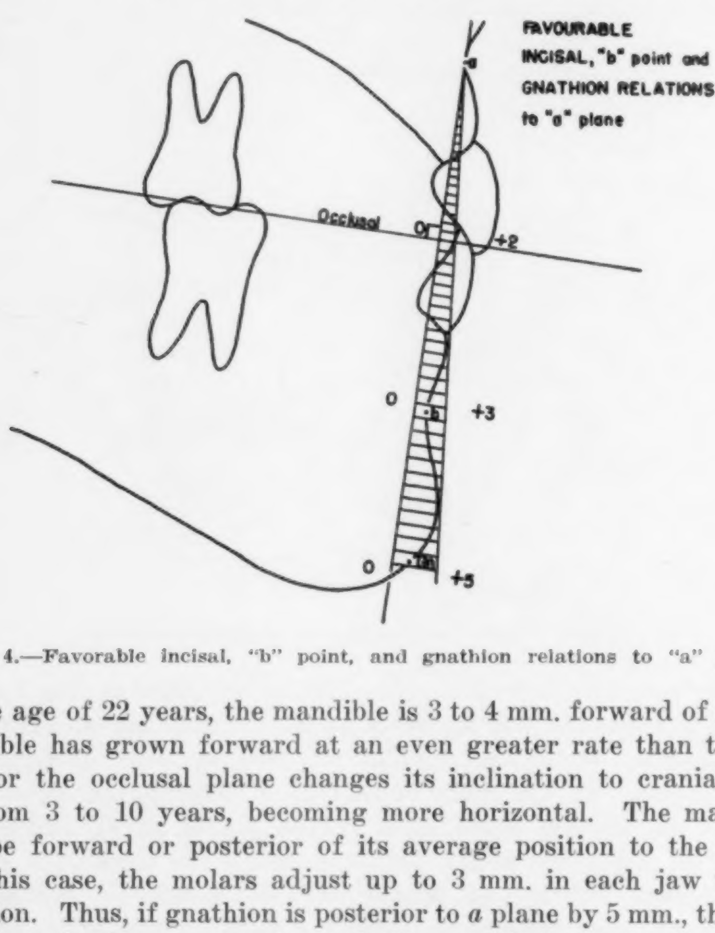

Fig. 4.—Favorable incisal, "b" point, and gnathion relations to "a" plane.

By the age of 22 years, the mandible is 3 to 4 mm. forward of the maxilla. The mandible has grown forward at an even greater rate than these figures indicate, for the occlusal plane changes its inclination to cranial base by 3 degrees from 3 to 10 years, becoming more horizontal. The mandible may normally be forward or posterior of its average position to the extent of 5 mm. In this case, the molars adjust up to 3 mm. in each jaw to maintain neutroclusion. Thus, if gnathion is posterior to *a* plane by 5 mm., the maxillary molar tends to be 3 mm. posterior and the mandibular molar 3 mm. anterior to average position. If the mandible is situated even further posteriorly, a change to Class II, Division 1 usually results.

In so far as the incisors are concerned, the lip is attached above *a* point and then drapes vertically to the bony chin. For this to occur, the incisors must be close to *a* plane.

The mandibular incisor incisal edge lies 2 to 3 mm. posteriorly to maxillary incisal edge. Lips display good esthetics when points *a*, incisor edge, *b*, and gnathion are harmoniously related in relation to *a* plane. If the mandible (gnathion) is forward of the average position, *b* point and the mandibular incisor also tend to be forward, though to a progressively lesser extent, since the mandibular incisor is closer to *a* point than to gnathion. Conversely, if gnathion is posterior to *a* plane, *b* point and the mandibular incisor also lie posteriorly, though to a lesser extent. If we can thus determine incisor incisal edge position, incisor inclination will be a variable largely dependent on jaw anteroposterior relations.

Thus, for beauty of lips and chin, points *a*, incisor edge, *b*, and *Gn* must exhibit harmony of pattern. If *a* equals *o*, being the point of origin, mandibular incisor, *b*, and *Gn* display optimum figures of +2 or +3 mm. If the gnathion value varies from –3 to +5, the mandibular incisor displays less variability of –1 to +3.

Thus, from *a* plane we can assess the growth requirement of a deficient mandible or the degree of overgrowth of a Class III mandible. We can further assess the comparative location of the dentures on their jaws and the incisor placement required for harmonious labial musculature on an individual basis. A fair amount of posterior latitude in incisor crown position is normally permitted, since tongue pressure is a diminishing influence in the teens where normal function is present.

These figures agree fairly well with those of Downs[7] and Bjork.[3] Jaw abnormality exhibits three average patterns:

Class II, Division 1	*b*, –5 *Gn*, –5	$\frac{6}{\ }$, postnormal	–2 mm.
Class II, Division 2	*b*, –4 *Gn*, –2	$\frac{6}{6}$, postnormal	–2 mm.
Class III	*b*, +10 *Gn*, +10	$\frac{\ }{6}$, postnormal	–4 mm.

Thus, in Class II, Division 1 and Class III conditions, the jaw relation exceeds normal limits and a change in molar relations results (although a dental malrelation alone is not unusual).

In Class II, Division 2, the mandible exhibits less deficiency but its denture is postnormal. Thus, in nonmutilated Class II cases of both divisions, the maxillary molar is near the posterior limit of normal adjustment and occlusal correction by further posterior molar movement is not possible. In nonmutilated Class II and III cases, therefore, the main deformity is mandibular malrelation to the maxilla. The molars broadly maintain their normal positions in each jaw, despite the bony malrelation. None of these conditions has been demonstrated to be self-correcting. Thus, the earliest possible control of a Class II or III tendency is desirable. Treatment of a young patient who exhibits good growth response may involve no more than correcting jaw relations. The favorable growth response is reflected in positive gnathion and

mandibular incisor values. The older patient usually does not exhibit a very exciting jaw growth response and, consequently, the older Class II case usually still displays mandibular deficiency after treatment. The maxillary lip and incisor require placement posteriorly to normal to de-emphasize the mandibular deficiency. Thus, a mandibular deficiency calls for an incisor placement posterior to *a* plane. Speaking in averages, this is not possible by conservative treatment, since the maxillary denture is already near the limit of posterior adjustment. The required treatment, of course, is not such a problem to us, since first premolars have come to be recognized as supernumerary teeth. We have also experienced, over the years, a change in profile fashions. Faces are being worn a little flatter this year. Presumably, Christian Dior is following the trend. Some men may prefer incisor point on or posterior to *a* plane, even with favorable jaw relations. This, of course, harmonizes well with the shorter teeth so popular since occlusal equilibration came into fashion.

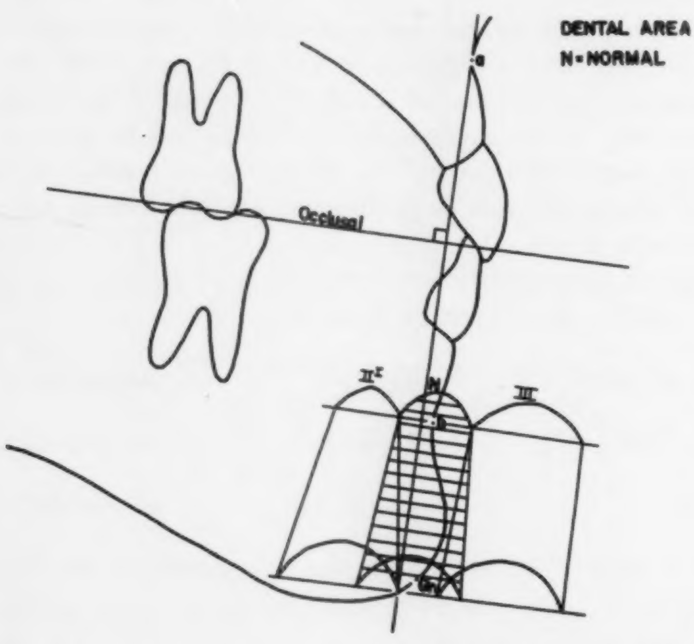

Fig. 5.—Gnathion and "b" point range in normal occlusion and Class II, Division 1, and Class III malocclusions.

All these relations described in the first session hold good, irrespective of the orientation of the jaws to the cranium. Why, then, is a study of jaw orientation useful?

ORIENTATION OF JAWS TO CRANIUM

The orientation of the jaws to the cranium interests us particularly for two reasons. The manner in which these two areas are put together plays a large part in determining (1) the actual and potential bony profile and (2) the direction of growth which the mandible is permitted. Thus, the main

morphologic deformity is manifest in the masticatory area, but the potential of the deformity appears to be manifest in the orientation of jaws to cranium. This orientation is determined by a great number of variables, as Wylie,[12] Björk,[3] and others have pointed out. Since these variables are relatively nonmodifiable by orthodontic procedures, for clinical purposes it is useful to summate these variables rather than to conduct a piecemeal analysis.

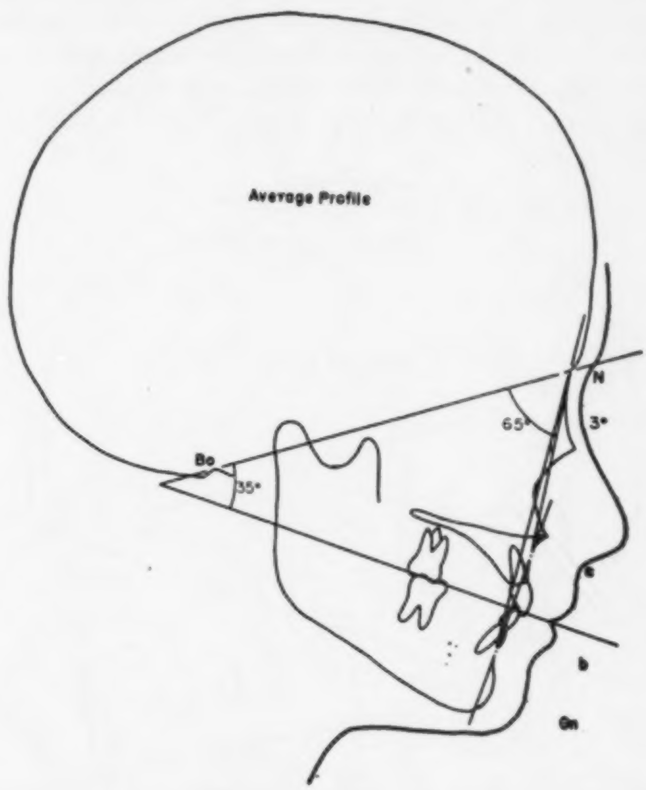

Fig. 6.—Normal group. Mean values for cranio-occlusal angle, 35 degrees; for craniofacial angle, 65 degrees. (Angle *aNb* = 3 degrees.)

Two angles are useful to represent this orientation of jaws to cranium: (1) the cranio-occlusal angle (CO), which measures vertical orientation, and (2) the craniofacial angle (CF), which measures horizontal orientation of jaw and cranial structures. These two angles have a low negative correlation, which implies some tendency for craniofacial angle to decrease as cranio-occlusal angle increases, with, however, a great deal of variability.

Cranio-occlusal Angle.—CO, the measure of vertical orientation, has a normal mean of 35 degrees and range of 25 to 45 degrees. The range is even greater in abnormal cases. Class II, Division 2 exhibits a significantly smaller mean of 31 degrees and a range of 25 to 38 degrees.

Profile.—In so far as skeletal pattern is concerned, three factors mainly affect the profile. These are CO, CF and gnathion. CO is the most intrinsic

quality in expressing profile. Other factors being equal, a small cranio-occlusal angle tends to define a square-jawed person with a straight profile; a large cranio-occlusal angle tends to produce a convex profile. In orthodontic deformity, the small cranio-occlusal angle pattern confers obvious benefits on the Class II condition and the reverse in Class III.

Functional Significance.—The occlusal plane is the plane of displacement of the mandible in the anteroposterior plane during function, growth, and in abnormality. Thus, the angle that this plane forms with the direction of resultant muscle pull on the mandible is of etiological and prognostic significance. A small cranio-occlusal angle implies a muscle pull more at right angles to the occlusal plane. An overactive musculature tends, then, to be of the

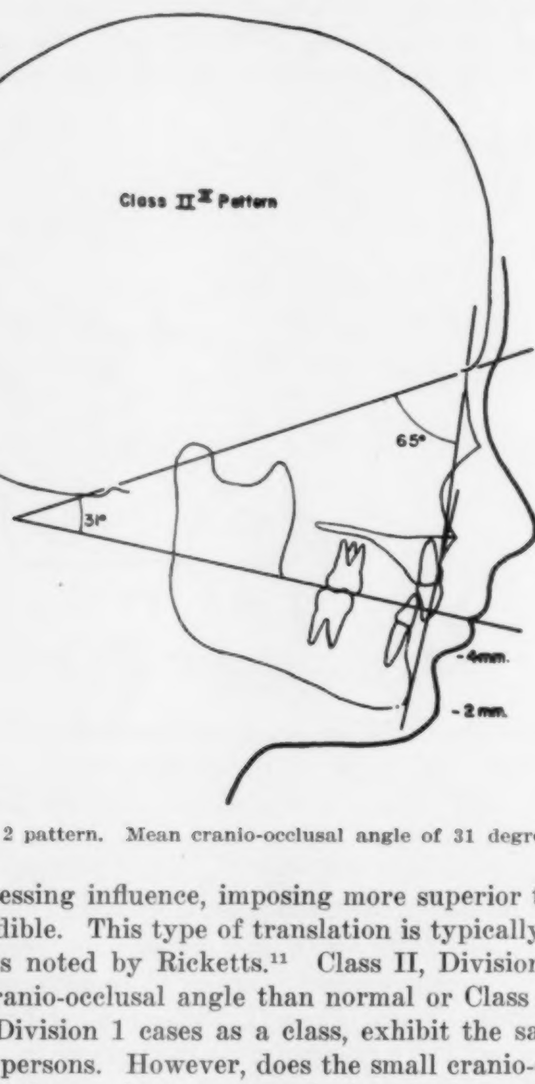

Fig. 7.—Class II, Division 2 pattern. Mean cranio-occlusal angle of 31 degrees is abnormal.

nature of a tooth-depressing influence, imposing more superior than posterior translation of the mandible. This type of translation is typically seen in Class II, Division 2 cases, as noted by Ricketts.[11] Class II, Division 2 exhibits a significantly smaller cranio-occlusal angle than normal or Class II, Division 1 conditions. Class II, Division 1 cases as a class, exhibit the same cranio-occlusal mean as normal persons. However, does the small cranio-occlusal angle Class II, Division 1 cases have a better prognosis than the large cranio-occlusal angle case?

We are gathering some evidence that use of a bite plate *alone* tends to inhibit condylar growth. The mechanics of this apparently is concerned with the Class III lever principle of the muscle pull interposed between incisors and condyle.

The orientation of the jaws to the cranium in the anteroposterior plane is the second profile variant. The craniofacial angle /BoNa, indicates the degree of maxillary prognathism or retrognathism. This angle has a normal

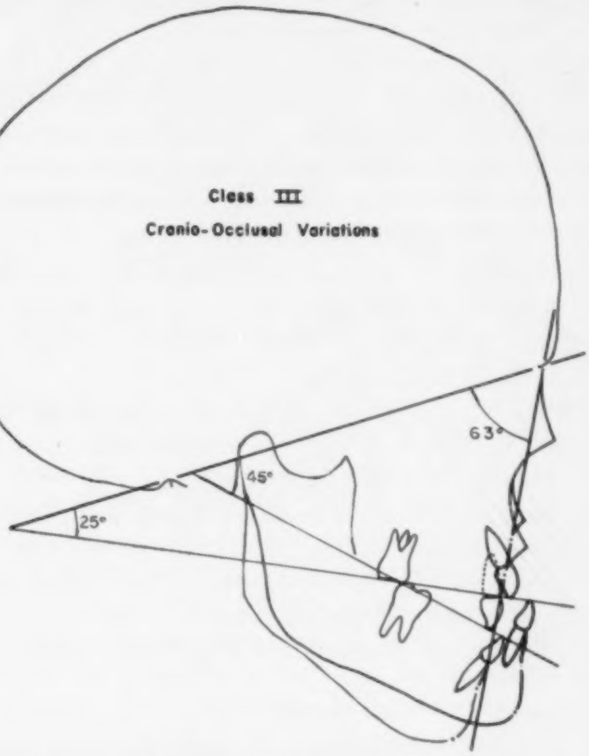

Fig. 8.—Class III patterns. Mean craniofacial angle of 63 degrees is abnormal. Large cranio-occlusal angle of 45 degrees minimizes esthetic disharmony; small cranio-occlusal angle of 25 degrees results in marked esthetic disharmony.

mean of 65 degrees and range of 58 to 72 degrees at all ages. Abnormal conditions display a similar mean and slightly greater range, except Class III, which exhibits an average angle of 63 degrees, indicating maxillary deficiency of 2 degrees which here represents approximately 2 mm. This has also been noted by Sanborn. Since abnormal faces, except those in Class III, exhibit the same mean as normal faces it is obvious that it is not the individual value of CF which is significant. Its value in relation to the CO angle and gnathion value is the important factor in assessing a favorable or unfavorable pattern.

We have noted that a large CO angle is unfavorable in Class II. Found in conjunction with a large CF, an undesirable profile results. This stresses the importance of early treatment to obtain optimum mandibular growth. Conversely, the small CF value usually found in Class III cases is disastrous with a small CO value. The degree of maxillary deficiency is usefully estimated

prior to measurement of mandibular overgrowth. Maxillary anteroposterior behavior during treatment is measured by using references Bolton plane and nasion.

Gnathion.—Gnathion value expresses the character of the lower face. It is superposed on CO and CF as the third component of facial profile in conjunction with dental influence. The gnathion value expresses mandibular prognathism or retrognathism in normal faces and protraction or retraction in abnormal faces. Favorable gnathion values and harmony of gnathion, *b* point, and incisor values are required for good esthetics.

Mandibular prognathism increases to maturity and results in a relative decrease in incisal prominence anteroposteriorly, although not with respect to *a* plane; *b* point is a useful index of mandibular alveolar development in reference to *a* plane, but it is susceptible to incisor pre-eruption formation and abnormal local musculature (for example, Class II, Division 2 or Class II, Division 1, displaying normal or favorable *Gn* value).

Individual Analysis.—As Downs[7] and others have stressed, it is not one individual value, but the harmony with which the components fit together, that we seek. Where disharmony exists, we have certain areas that we can modify to bring harmony to the whole.

The mandible and dental arches in the anteroposterior plane are the areas which are most susceptible, not only to orthodontic deformity, but also to orthodontic modification, excluding cleft palates.

The unexpended reserve of the young child gives us the power to redirect the abnormal growth pattern of the jaws. However, only a residue of this growth reserve remains to the teen-ager, and dento-alveolar modification is the clay of our potter's wheel. Cephalometrics is perhaps our most valuable laboratory tool in the required assessment of an orthodontic patient.

REFERENCES

1. Angle, E. H.: Treatment of Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Dental Mf. Company.
2. Baum, A. T.: A Cephalometric Evaluation of the Normal Skeletal and Dental Patterns of Children With Excellent Occlusions, Angle Orthodontist 21: 96-103, 1951.
3. Björk, A.: Some Biological Aspects of Prognathism and Occlusion of the Teeth, Angle Orthodontist 21: 3-27, 1951.
4. Björk, A.: The Face in Profile (Abstract), Am. J. Orthodontics 34: 691-699, 1948.
5. Broadbent, B. H.: The Face of the Normal Child, Angle Orthodontist 7: 203, 1937.
6. Brodie, A. G.: Late Growth Changes in the Human Face, Angle Orthodontist 23: 146-157, 1953.
7. Downs, W. B.: Variations in Facial Relationships, Their Significance in Treatment and Prognosis, Am. J. Orthodontics 34: 812-820, 1948.
8. Howes, A. E.: Case Analysis and Treatment Planning, Am. J. Orthodontics & Oral Surg. 33: 499-533, 1947.
9. Lande, M. J.: Growth Behavior of the Human Facial Profile as Revealed by Serial Cephalometric Roentgenology, Angle Orthodontist 22: 78-90, 1952.
10. Prakash, P., and Margolis, H. T.: Dento-Craniofacial Relations in Varying Degrees of Overbite, Am. J. Orthodontics 38: 657-673, 1952.
11. Ricketts, R. M.: Variations of the Temporomandibular Joint as Revealed by Cephalometric Laminagraphy, Am. J. Orthodontics 36: 877-898, 1950.
12. Wylie, W. L.: Antero-posterior Dysplasia, Angle Orthodontist 17: 97-109, 1947.

A PHOTOMETRIC ANALYSIS OF THE FACIAL PROFILE

A Method of Assessing Facial Change Induced by Orthodontic Treatment

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THE study of orthodontia is indissolubly connected with that of art as related to the human face. The mouth is a most potent factor in making or marring the beauty and character of the face." These words, written by Edward H. Angle[1] in 1907, prefaced a very comprehensive discussion of facial art as related to orthodontics. The improvement of facial form has always been recognized as one of the prime requisites of satisfactory orthodontic therapy. Throughout the years, in dental and orthodontic literature, constant reference is found concerning the effect of mechanical therapy on facial contour. The orthodontic profession has passed beyond the era of being merely "tooth straighteners." The public is now receiving the benefits of an ever-expanding concept that has been progressing through the years. The development of this concept has taken years of clinical investigation and academic research. Much has been written about the various attempts to classify and develop a basis for our current beliefs. The classical studies in growth and development of the normal child, such as were done by Hellman,[2] Broadbent,[3] Brodie,[4] and many others, serve as excellent examples of the progress of our thinking. Professionally, it is our duty to apply that knowledge which has been gained during the past several decades.

In practically all case reports we find photographs representing facial contour both before and after treatment. Although the change is quite striking on some, criteria for defining an ideal facial contour are based on standards that seem at present to be vague. Charles H. Tweed[5] has defined his concept of "normal" in its relation to facial contour as being "that balance and harmony of proportions considered by the majority of us as most pleasing in the human face."

To stress our point still further, Edmund H. Wuerpel[6] gave us our clue to the solution of acceptable standards for analysis of facial form when he said: "Beauty is the finest expression of human emotions. . . . The art that was produced in the past has survived because it was expressed in the highest, finest, most sensitive manner possible. The beauty that survives knows no limits either of time or place." Each man's concept of beauty is a matter

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of his own innermost sensibility and understanding. However, there most certainly is considerable agreement among many of us that certain faces fall well within the definition of beauty or harmony of form.

In general, orthodontists concede that we may readily correlate cephalometric pattern with soft tissue form. Margolis,[7] in discussing basic facial pattern, demonstrated a method of relating the anatomic and soft tissue structures to the facial profile by superimposing profile photographs over lateral cephalic radiographs. Björk,[8] in a masterful study published in 1947, has given us valuable information on the facial form of a sample of Scandinavian boys. Higley and Speidel[9] in 1938 described a technique of outlining the soft tissue profile on the lateral cephalic radiograph.

In clinical practice, many men are adapting the use of cephalometrics as an aid to diagnosis. The use of variable standards in the study of cephalometric tracings, according to the methods of Downs[10] Wylie,[11] Margolis,[12] and others, has given the profession a basis from which to expand the ever-broadening concept of the normal and abnormal skeletal pattern. Change in soft tissue profile is usually observed when there has been a marked change in the cephalometric radiographs. All this, of course, reflects back to changes due to growth or orthodontic treatment.

Benjamin J. Herzberg[13] has concluded that the majority of patients desire orthodontic service for two reasons, namely, "the presence of facial disharmony, or facial deformity and malalignment of the teeth, or both." In all probability, most of us will agree with this. We know that the patient is little interested in the bony changes or the angulation of the teeth as exhibited in a cephalometric radiograph. He is decidedly interested in seeing an improvement in the protrusion of the lips, the curl of the lower lip, the apparent growth or forward displacement of the chin. What a crime it would be not to obtain such change if it is possible by orthodontic means!

The recent emphasis on the improvement of facial balance as being one of the prime motivating factors for the method and objectives of treatment has led Tweed[5] to develop his rule of "compensation." This, of course, is the principle of clinically relating the mandibular incisor axis to the mandibular plane in plus or minus equivalents according to the variation of the Frankfort-mandibular plane angle. He feels that ideal facial balance is reached in a given patient, regardless of the severity of the Frankfort-mandibular plane angle, if, clinically, the axis of the mandibular incisor can be made to reach a 65 degree angle with the Frankfort plane. If this is true, then a method of evaluating change in soft tissue would be very valuable.

What will be offered here is one method of assessing the disharmonies of facial balance and establishing criteria for determining the extent of change in the facial profile due to orthodontic treatment.

METHOD

In order to provide subject material for evaluating facial contour around the mouth, the area affected by orthodontic treatment, two samples of profile

photographs were selected. The first sample consisted of thirty-four profile photographs of faces that exhibited excellent form and balance (Fig. 1). These photographs were taken from case reports in dental and orthodontic literature. They represent, for the most part, photographs of patients treated by some of the most respected members of our profession. Reference is made at this point to the work of Riddell[14] who reports that there seems to be uniformity among the orthodontists in selecting excellent facial profile photographs.

Fig. 1.—A group of profile photographs which represent excellent form and harmony of contour.

The second sample was pretreatment and posttreatment profile photographs of fifty consecutively treated cases taken from my practice. No attempt was made to sort the satisfactory profile changes from the poor ones. The finished treatment photographs were taken at the time appliances were removed. The interval between the two photographs averaged eighteen to twenty-four months. The pretreatment occlusion on the second sample was divided as follows: Class I, twenty-one cases; Class II, Division 1, nineteen cases; Class II, Division 2, three cases; Class III, seven cases.

The selection of two separate samples was made for the purpose of (1) establishing a method whereby facial change could be recorded in treated cases, and (2) setting standards, if any, for a range of variation for acceptable facial profiles.

If a study of this type is to be valuable, facial contour should be recorded by using such points as may be influenced by orthodontic treatment (Fig. 2). Point *C* (chin) was used to record changes due to either growth or treatment in location of the chin. It is related to the rest of the head by using the Frankfort plane. A retrusive face must be recorded in terms of a small facial angle. Conversely, a vertical or protrusive face would be recorded as a larger facial angle. This is in accordance with the methods used cephalometrically by Downs[10] and others on lateral cephalic radiographs of the skull.

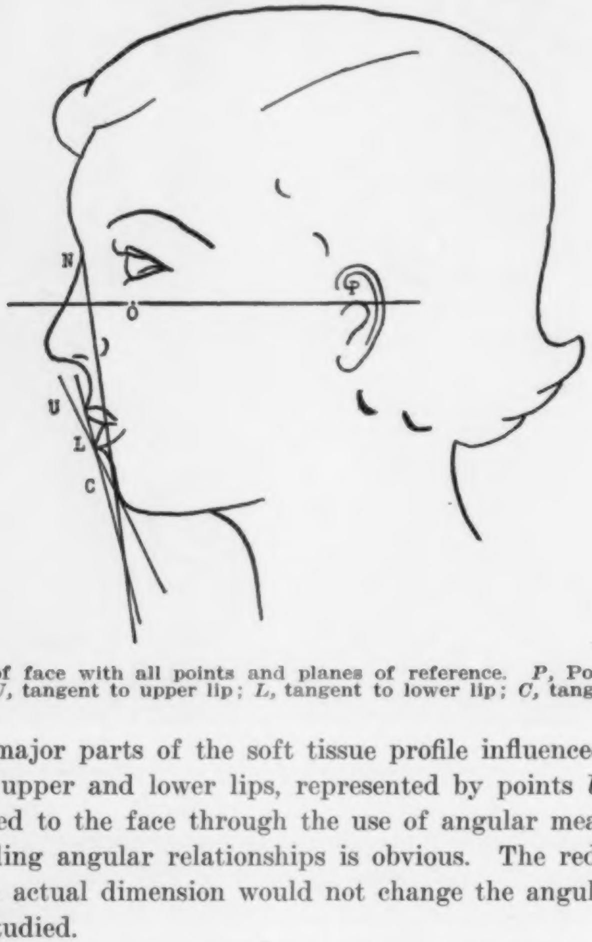


Fig. 2.—Drawing of face with all points and planes of reference. *P*, Porion; *N*, nasion; *O*, orbitale; *U*, tangent to upper lip; *L*, tangent to lower lip; *C*, tangent to chin.

The other major parts of the soft tissue profile influenced by orthodontic service are the upper and lower lips, represented by points *U* and *L*. These points are related to the face through the use of angular measurements. The choice of recording angular relationships is obvious. The reduction in photograph size from actual dimension would not change the angular proportion of the parts to be studied.

The following planes were selected for reference (Fig. 2):

Frankfort plane, *PO*, was drawn from Tragion (being standardized as the lowest margin of the tragus as it passes posteriorly on the ear) to orbitale.

Facial plane, *NC*, was drawn from the depth of concavity at the base of the nose, *N*, to a tangent to the chin, *C*.

The relationship of the lower lip to chin point was drawn as plane *LC*, connecting a tangent from lower lip, *L*, to chin, *C*.

The relationship of the upper lip to the lower lip, *UL*, was established by connecting tangents from upper lip, *U*, to lower lip, *L*.

Inclusion in this study of a plane connecting upper lip, *U*, to chin, *C*, was contemplated. Tracings on several patients demonstrated that the lines fell so near the *LC* plane that confusion would result from lines so close together. Therefore, the upper lip is considered as indirectly related to the facial plane through the *UL* plane.

FINDINGS

A. *Excellent Profile Sample.*—

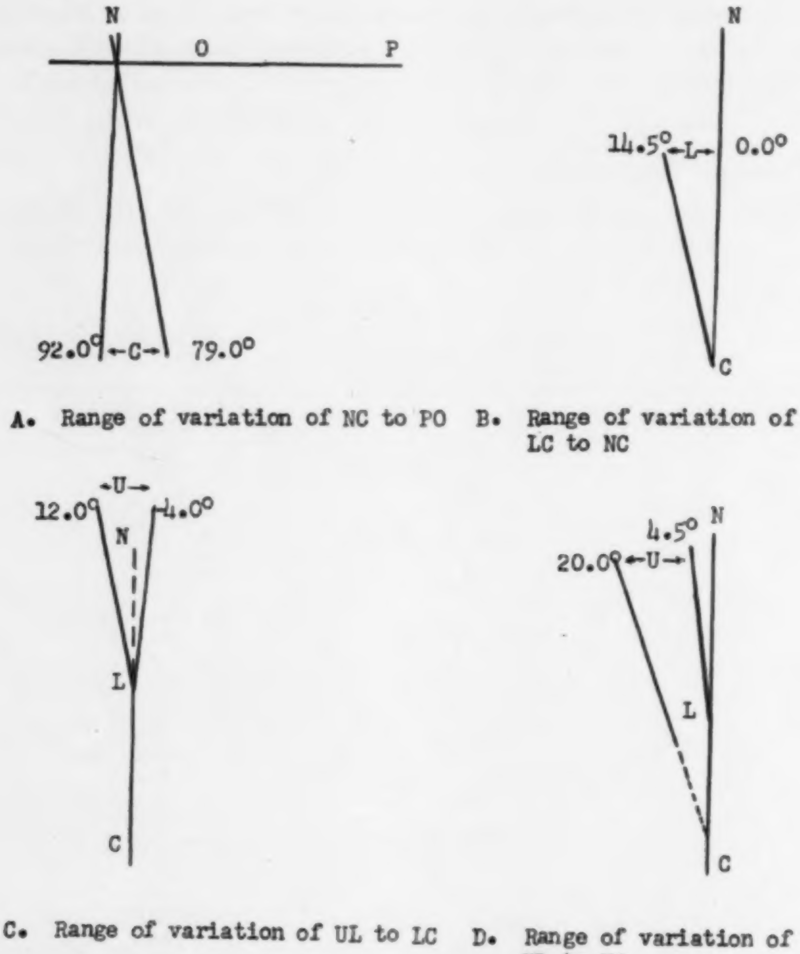
1. The facial angle, represented by the intersection of *PO* and *NC*, ranged from 79.0 to 92.0 degrees, having an arithmetic mean of 87.7 degrees ± 2.9 degrees (Table I, Fig. 3, *A*).

TABLE I. THE ANGULAR RELATIONSHIP OF FACIAL PLANE NC TO FRANKFORT PLANE PO ON THIRTY-FOUR PROFILE PHOTOGRAPHS OF EXCELLENT FACIAL FORM

CASE NUMBER	∠ PO-NC (DEGREES)
2	79.0
3	82.0
9	83.0
11	83.0
30	83.0
16	83.5
10	85.0
21	85.0
31	85.0
13	85.5
18	85.5
8	86.0
12	86.0
15	86.0
6	86.5
4	87.0
5	87.0
19	87.0
20	87.0
29	87.0
27	87.5
14	88.0
22	88.0
34	88.5
17	88.5
33	89.0
23	89.5
1	89.5
7	90.0
32	90.5
28	90.5
24	90.5
26	91.0
25	92.0
Arithmetic mean	87.7
Standard deviation	±2.9

2. The protrusion of the lower lip as related to the chin is presented by the angle formed at *NC-LC*. It ranged from 0.0 to 14.5 degrees, having an arithmetic mean of 7.3 degrees ± 3.3 degrees (Table II, Figure 3, *B*).

3. The relationship of the upper lip to the lower lip, recorded by the intersection of *UL* and *CL*, showed a range of –4.0 to 12.0 degrees. (The negative angle represents retrusion of the upper lip as compared to the lower lip.) The arithmetic mean was 5.3 degrees ± 3.9 degrees (Table III, Fig. 3, *C*).



A. Range of variation of NC to PO B. Range of variation of LC to NC

C. Range of variation of UL to LC D. Range of variation of UL to NC

Fig. 3.—Angular variations on sample of thirty-four "excellent profile" photographs.

4. The relationship of the lip plane *UL*, to the facial plane, *NC*, ranged from 4.5 to 20.0 degrees having an arithmetic mean of 12.5 degrees ± 3.6 degrees (Table IV, Fig. 3, *D*).

B. *Pretreatment Profiles of the Second Sample (Table V, Column 1).*—

1. The facial angle, hereafter referred to as ∠*PO-NC*, ranged for the entire sample from 72.5 to 93.0 degrees.

TABLE II. THE ANGULAR RELATIONSHIP OF CHIN-LOWER LIP PLANE LC TO FACIAL PLANE NC ON THIRTY-FOUR PROFILE PHOTOGRAPHS OF EXCELLENT FACIAL FORM

CASE NUMBER	∠ LC-NC (DEGREES)
3	0.0
24	0.0
5	4.0
18	4.0
34	4.0
14	5.0
22	5.0
25	5.0
28	5.0
32	5.0
4	5.0
1	5.5
2	5.5
13	5.5
20	5.5
23	6.0
15	7.0
26	7.0
33	7.5
31	7.5
6	8.0
21	8.0
29	8.5
12	8.5
8	8.5
9	9.0
11	9.0
27	9.5
19	10.0
10	11.5
30	12.0
16	12.0
17	14.0
7	14.5
Arithmetic mean	7.3
Standard deviation	±3.3

2. The protrusion of the lower lip, ∠*NC-LC*, ranged from 0.0 to 32.5 degrees.

3. The upper lip to the lower lip, ∠*UL-LC*, measured –29.0 to +20.0 degrees.

4. The lip plane to the facial plane, ∠*UL-NC*, measured –25.0 to +28.0 degrees.

This pretreatment sample included all types of cases, from excellent profiles to severe. Note that the range of measurements of ∠*NC-LC*, ∠*UL-LC*, and ∠*UL-NC* on the pretreatment series was more than double the range of the excellent profile series. However, the facial angle, ∠*PO-NC*, had an over-all range of only 4.5 degrees greater on the pretreatment series as compared to the good profiles. This would seem to indicate that the position of the chin point did not affect too greatly the over-all balance of the face. It might also explain the range of balance in various facial types.

TABLE III. THE ANGULAR RELATIONSHIP OF THE UPPER LIP TO THE LOWER LIP RECORDED BY THE INTERSECTION OF UL WITH LC ON THIRTY-FOUR PROFILE PHOTOGRAPHS OF EXCELLENT FACIAL FORM

CASE NUMBER	∠ LC-UL (DEGREES)
11	-4.0
10	0.0
9	0.0
31	0.0
8	0.0
20	0.0
17	0.0
7	0.0
34	0.5
21	3.5
6	4.0
18	4.5
30	5.0
5	5.0
29	5.0
26	5.0
33	5.5
2	6.0
15	6.0
27	6.0
22	6.5
14	6.5
16	7.0
1	7.5
12	7.5
13	7.5
4	8.0
23	8.0
25	8.0
19	10.0
24	10.5
28	11.5
3	12.0
32	12.0
Arithmetic mean	5.3
Standard deviation	±3.9

C. *Posttreatment Profiles of the Second Sample.*—The posttreatment profiles of the second sample were recorded as follows (Table V, Column 2):

1. ∠ *PO-NC*— 75.0 to 90.0 degrees
2. ∠ *NC-LC*— 0.0 to 33.5 degrees
3. ∠ *UL-LC*—-27.0 to 22.0 degrees
4. ∠ *UL-NC*— -1.0 to 22.0 degrees

A comparison of the posttreatment records with the pretreatment records shows very little change for the entire series on ∠ *PO-NC,* ∠ *NC-LC,* and ∠ *UL-LC.* ∠ *UL-NC* showed considerable change (see Table V). Re-examining the original photographs, we find that this change occurred in the Class III treatment series where the retrusion of the upper lip was reduced (Figs. 4 and 5). Since there were but two extreme cases of this type, the treatment change, which was considerable, was reflected in the great reduction of the over-all range.

TABLE IV. THE ANGULAR RELATIONSHIP OF THE UPPER AND LOWER LIP PLANE, UL, TO FACIAL PLANE, NC, ON THIRTY-FOUR PROFILE PHOTOGRAPHS OF EXCELLENT FACIAL FORM

CASE NUMBER	∠ UL-NC (DEGREES)
34	4.5
11	5.0
20	5.5
31	7.5
18	8.5
8	8.5
5	9.0
9	9.0
24	10.5
2	11.5
10	11.5
14	11.5
21	11.5
22	11.5
3	12.0
6	12.0
26	12.0
1	13.0
4	13.0
13	13.0
15	13.0
25	13.0
33	13.0
29	13.5
23	14.0
17	14.0
7	14.5
27	15.0
12	16.0
28	16.5
32	17.0
30	17.0
16	19.0
19	20.0
Arithmetic mean	12.5
Standard deviation	±3.6

An analysis of these records at this stage would seem to indicate that on this sample of treated cases there was very little over-all profile change. However, this was not the case. All posttreatment samples were divided into two groups, those in which the individual measurements fell within the range of the excellent-profile series, and those profile photographs in which one or more measurements fell outside the satisfactory sample series.

TABLE V. SUMMARY OF THE RANGE OF MEASUREMENTS IN ALL THE PHOTOGRAPHS MEASURED

ANGLE	RANGE OF VARIATION ON PRETREATMENT SAMPLE (DEGREES)	RANGE OF VARIATION ON PREVIOUS PHOTOGRAPHS AFTER TREATMENT (DEGREES)	RANGE OF VARIATION ON EXCELLENT PROFILE SAMPLE (DEGREES)
∠ PO-NC	72.5 to 93.0	75.0 to 90.0	79.0 to 92.0
∠ NC-LC	0.0 to 32.5	0.0 to 33.5	0.0 to 14.5
∠ UL-LC	-29.0 to 20.0	-27.0 to 22.0	-4.0 to 12.0
∠ UL-NC	-25.0 to 28.0	– 1.0 to 22.0	4.5 to 20.0

In the first group, as was expected, all the photographs were examples of excellent balance and form (Figs. 6 and 7). In the second group, in some in-

Fig. 4.

Fig. 5.

Fig. 4.—Change in upper and lower lip plane following correction of a Class III malocclusion.

Fig. 5.—Change in the upper and lower lip plane following correction of a Class III malocclusion. In this case there was also a 2.5-degree reduction in the facial plane angle.

Fig. 6.

Fig. 7.

Fig. 6.—This case demonstrates considerable change on all the measurements involved in this study. The finished treatment profile fits into the excellent balance range.

Fig. 7.—An example of profile change in which the end results of treatment place all the measurements into the excellent balance range.

stances, were photographs of patients who had considerable facial change as a result of orthodontic treatment but still did not represent the excellent balance and harmony of form that would classify the face into Group 1 (Fig. 8). There were also included in this group examples of patients who had little or no facial improvement (Figs. 9 and 10).

To compare the changes before and after orthodontic treatment, the measurements of each patient were tabulated, as exhibited in the following case reports. The change in position of the upper lip is discussed in the analysis of the first case.

Fig. 8.—An example of "severe" facial pattern in which there was considerable improvement. However, the end result was still outside the excellent balance range.

CASE REPORTS

CASE 3A.—The patient was an 11-year-old boy with a Class II, Division 1 malocclusion (Fig. 8). Treatment time was twenty-three months.

ANGLE	PRETREATMENT (DEGREES)	POSTTREATMENT (DEGREES)	NET CHANGE (DEGREES)	GOOD BALANCE RANGE (DEGREES)
∠ PO-NC	89.9	88.0	- 1.0	79.0 to 92.0
∠ NC-LC	31.0	24.0	- 7.0	0.0 to 14.5
∠ UL-LC	-19.5	-3.5	+16.0	-4.0 to 12.0
∠ UL-NC	11.5	20.5	+ 9.0	4.5 to 20.0

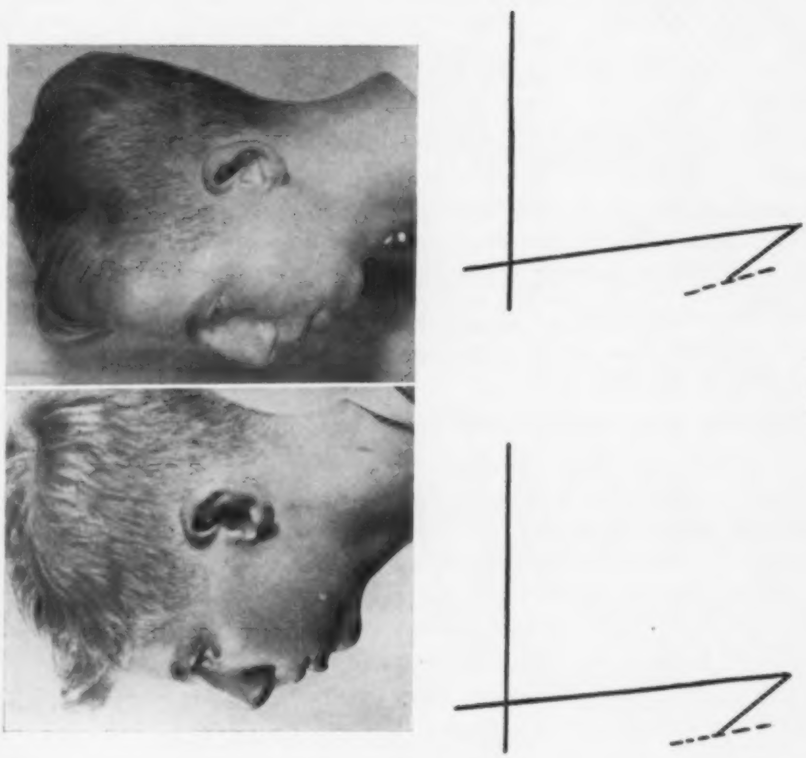


Fig. 9.

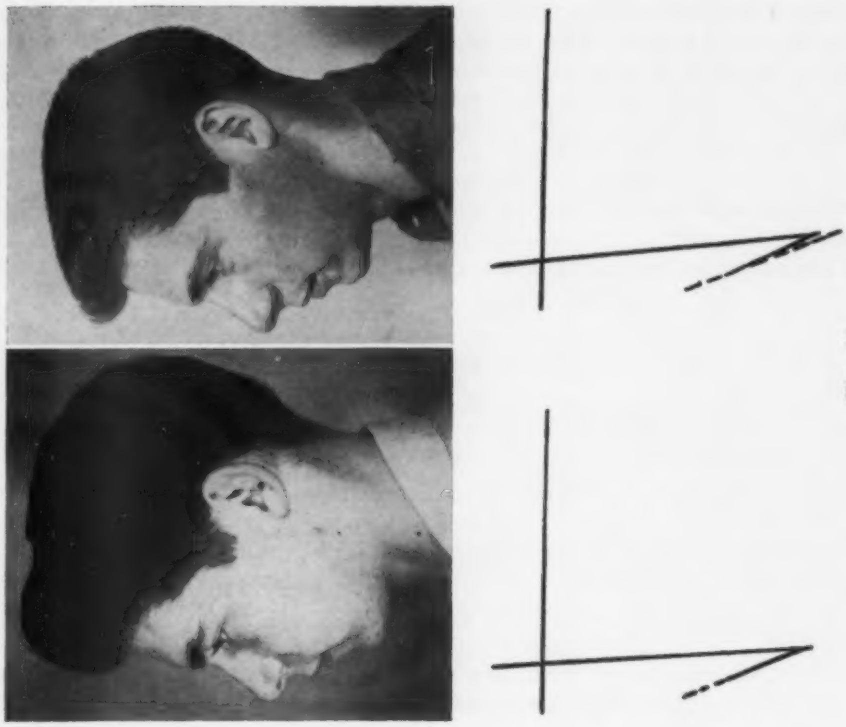


Fig. 10.

Fig. 9.—An example of "severe" facial pattern in which there was little or no facial improvement.
Fig. 10.—An example of "fair" facial pattern in which there was little or no facial improvement.

Let us analyze the readings tabulated on page 464. ∠ *PO-NC* did not improve. In fact, there was a reduction of 1.0 degree in the facial angle. This means that the chin point remained approximately in the same place after treatment as before. If this is true, the 7.0-degree reduction in ∠ *NC-LC* means that the lower lip protrusion was reduced. If the upper lip were proportionately reduced, the *UL-NC* reading would remain the same. If the upper lip remained in its original position, the *UL-NC* angle should have increased. We can arithmetically appraise the change in the upper lip as follows: The net change in ∠ *PO-NC* plus the net change in ∠ *NC-LC* is added to the net change in ∠ *UL-NC*. The final sum, designated in plus or minus values, will indicate whether point *U* has moved away from or back toward the face. In this particular case the formula is applied as follows:

∠ *PO-NC* net change −1.0 degree
∠ *NC-LC* net change −7.0 degrees
∠ *NC-UL* net change +9.0 degrees

+1.0 degree

(This formula will be applied to the remaining cases discussed in this article.)

We can now evaluate the readings of the treatment photographs. There was a 1-degree retrusion in chin point. The final result was still within ideal limits. The 7-degree retrusion of the lower lip showed considerable improvement but still did not meet desirable limits. The relationship of the upper lip to the lower lip did improve to within good range. There was no improvement in the relationship of the upper lip to the face. This measurement was just outside the ideal range.

Case 40A.—This case demonstrates very little facial change. The patient was a boy, 15 years of age, with a Class I malocclusion (Fig. 10). Treatment time was eighteen months.

ANGLE	PRETREATMENT (DEGREES)	POSTTREATMENT (DEGREES)	NET CHANGE (DEGREES)	EXCELLENT BALANCE RANGE (DEGREES)
∠ PO-NC	86.0	84.0	-2.0	79.0 to 92.0
∠ NC-LC	17.5	19.5	+2.0	0.0 to 14.5
∠ UL-LC	0.0	-3.5	-3.5	-4.0 to 12.0
∠ UL-NC	17.5	16.0	-1.5	4.5 to 20.0

Upper lip formula: (-2.0) + (+2.0) + (-1.5) = -1.5.

In this case, reduction in the facial plane, plus the increase in the lower lip angle applied to the formula related in the previous case (net change in sum of ∠ *PO-NC*, ∠ *NC-LC*, and ∠ *UL-NC* equals net change in point *U*), shows that the protrusion of *U* point was reduced −1.5 degrees. The lower lip, *L*, remained in the same relative position in space because of the reduction in the *PO-NC* angle, which neutralized the increase in ∠ *NC-LC*.

Net result: All measurements are in harmony with the excellent facial standards except the *LC* plane, which is protrusive.

The following cases demonstrate posttreatment photographs which place these patients in the excellent form range.

Case 8A.—The patient was a 12-year-old girl who had a Class I malocclusion (Fig. 6). Treatment time was twenty-two months.

ANGLE	PRETREATMENT (DEGREES)	POSTTREATMENT (DEGREES)	NET CHANGE (DEGREES)	EXCELLENT BALANCE RANGE (DEGREES)
∠ PO-NC	85.0	83.0	- 2.0	79.0 to 92.0
∠ NC-LC	21.0	9.5	-11.5	0.0 to 14.5
∠ UL-LC	-20.0	0.0	+20.0	-4.0 to 12.0
∠ UL-NC	1.0	9.5	+ 8.5	4.5 to 20.0

Upper lip formula: (-2.0) + (-11.5) - (+8.5) = -5.0.

Analysis shows, according to the formula expressed on page 466, that the upper lip was brought back 5.0 degrees. The lower lip angle was reduced 11.5 degrees. This, plus the 2.0-degree reduction in chin point, left a net reduction of lower lip of 13.5 degrees. The *UL* plane increased to fall into the excellent balance range.

Net result: All measurements fall into excellent balance range. The facial form is very desirable.

CASE 36A.—The patient, a girl of 14, had a Class I malocclusion. Treatment time was nineteen months.

ANGLE	PRETREATMENT (DEGREES)	POSTTREATMENT (DEGREES)	NET CHANGE (DEGREES)	EXCELLENT BALANCE RANGE (DEGREES)
∠ PO-NC	89.0	86.5	− 2.5	79.0 to 92.0
∠ NC-LC	11.5	5.5	− 6.0	0.0 to 14.5
∠ UL-LC	-11.0	3.0	+14.0	-4.0 to 12.0
∠ UL-NC	0.5	8.5	+ 8.0	4.5 to 20.0

Upper lip formula: $(2.5) + (-6.0) + (+8.0) = -0.5$.

A glance at the pretreatment readings shows the lips to be protrusive. The changes resulting from treatment brought all the readings into the "ideal" range. The improvement in the upper lip was negligible, with a net change of -0.5 degree. The 8- and 14-degree increases in the two *UL* readings demonstrate the location of the correction. Note that the chin point did not move forward, but was reduced 2.5 degrees.

DISCUSSION

It was a great revelation to discover that changes occurring in facial profile, when measured this way, revealed some prime defects in the original analysis.

It is not necessarily implied that all changes occurring in and about the mouth are due to orthodontic therapy. As is generally understood, some of the change could have resulted either from growth or from improvement in health and habits. However, it is not the intention of this article to imply that one method of treatment may be superior to another. There has been no comparison of the efficiency of the type of treatment involved in producing results.

There is no doubt that we do have within our power the means to influence soft tissue contour. There are, of course, many limitations—some mechanical and some anatomic. The profession can only judge the success of its efforts by the clinical results produced. As more information and better methods are obtained by which these results may be assessed, there can be better service to the patient.

The difficulty in selecting soft tissue landmarks, as well as their relative instability, has always been the deterring factor for the selection of a study of this type. As yet, there are no ideal methods offered to record change. Hellman's[2] profilograms could be very useful. Anthropometric records on soft tissue, as suggested by Gosman[15] and Elsasser,[16] are undoubtedly valuable. Photostatic records as advocated by McCoy[17] are perhaps the most popular method in current use. The objections offered to these methods are twofold: They require a great deal of clinical time and effort, and they do not record changes in the area where orthodontic therapy shows its greatest influence—the contour of the lips.

It may be noted that this is a statistical study. Therefore, the mean and standard deviations of each record were tabulated. The value of a biometric study depends upon its usefulness. The excellent profile photographs were selected because each one represented an artistic balance of the facial contour. There was no question regarding selection of one particular type as being better than another. If comparisons are made to a mean value of any of the readings, we would no longer have a useful guide by which all types of faces can be evaluated. Therefore, we have considered the over-all range as the standard for comparison of the individual measurement. It is our opinion that, by using a range of values, the variation of different types of patients would be included in this range when the facial profile is in excellent balance. As has been previously stated in this article, the over-all comparison of the range of measurements of the fifty pretreatment photographs with those of the "ideal balance" series showed very little difference in the range of facial plane angle. The inference may be drawn from this that location of the chin (which may be one method of assessing facial type) had very little value in determining the harmony of the facial profile.

SUMMARY

1. A method has been offered which makes possible the application of the principles of craniometrics and cephalometrics to the profile outline of the face. This may be done on the soft-tissue shadow of the cephalic radiograph or, as was done in this study, directly on the profile photograph.

2. By use of angular readings, a range of measurements on thirty-four excellent faces was established (Figs. 1 and 2; Table V, column 3).

3. A study of fifty pretreatment and posttreatment photographs revealed that the excellent facial changes all fit into the range of measurements found in the preceding standards.

4. By comparing the changes in the posttreatment photographs with those of the pretreatment photographs, we can see exactly how orthodontic service changed the facial contour.

CONCLUSIONS

The acceptable faces, namely, those cases which have been selected as being well balanced and in excellent proportion, represent an individual concept of beauty. It is not the intention of this article to suggest that the profession at large accept these standards. However, if any of the members feel that these faces fit within their concept of desirability, then the method and findings offered in this article should give the clinical orthodontist a means of judging the effects of his treatment on the facial profile.

REFERENCES

1. Angle, E. H.: Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Dental Manufacturing Company, p. 60.
2. Hellman, Milo: Changes in the Human Face Brought About by Development, INT. J. ORTHODONTIA 13: 475-516, 1927.
3. Broadbent, B. Holly: The Face of the Normal Child, Angle Orthodontist 7: 183-208, 1937.

4. Brodie, Allan G.. On the Growth Pattern of the Human Head From the Third Month to the Eighth Year of Life, Am. J. Anat. **68**: 209, 1941.
5. Tweed, Charles H.: Evolutionary Trends in Orthodontia, AM. J. ORTHODONTICS **39**: 81-108, 1953.
6. Wuerpel, Edmund H.: Culture and Its Recompense, The Inspiration of Beauty, Angle Orthodontist **2**: 132, 1932.
7. Margolis, Herbert I.: A Basic Facial Pattern and Its Application in Clinical Orthodontics. I. The Maxillofacial Triangle, AM. J. ORTHODONTICS AND ORAL SURG. **33**: 631-641, 1947.
8. Björk, Arne: The Face in Profile—An Anthropological Investigation of Swedish Children and Conscripts, Svensk Tandläkare-Tidskrift **40**: No. 5B, Supp. Lund, 1947.
9. Higley, L. B., and Speidel, T. D.: Preliminary Studies of Orthodontic Results as Revealed by Roentgenographic Cephalometric Records, AM. J. ORTHODONTICS AND ORAL SURG. **34**: 1039-1050, 1938.
10. Downs, William B.: Variations in Facial Relationship: Their Significance in Treatment and Prognosis, AM. J. ORTHODONTICS **34**: 812-840, 1948.
11. Wylie, Wendell L.: Assessment of Anterioposterio Displasia, Angle Orthodontist **17**: 97-109, 1947.
12. Margolis, Herbert I.: A Basic Pattern and Its Application in Clinical Orthodontics. II. Craniofacial Skeletal Analysis (cont'd), and Dentocraniofacial Orientation, AM. J. ORTHODONTICS **39**: 425-443, 1943.
13. Herzberg, Benjamin J.: Facial Esthetics in Relation to Orthodontic Treatment, Angle Orthodontist **22**: 3-22, 1952.
14. Riddell, Richard: Esthetics and Its Relation to Orthodontic Therapy, Angle Orthodontist **20**: 168-178, 1950.
15. Gosman, S. D.: Anthropometric Method of Facial Analysis in Orthodontics, AM. J. ORTHODONTICS **36**: 749-762, 1950.
16. Elsasser, William A.: Studies in Dentofacial Morphology. II. Orthometric Analysis of Facial Pattern, AM. J. ORTHODONTICS **39**: 193-200, 1953.
17. McCoy, James D.: Applied Orthodontics, ed. 6, Philadelphia, 1946, Lea & Febiger, p. 132.

40 WEST 38TH ST.

A POSSIBLE EXPLANATION FOR DIZZINESS IN COSTEN'S SYNDROME

STANLEY DAVID CARLSON, D.D.S., M.S.D.,* MILWAUKEE, WIS.

MANY articles have appeared in the literature during the last thirty-five years concerning the etiology of certain signs and symptoms of Costen's syndrome,[1] and, according to Zimmerman,[2] serious misstatements of anatomic facts and misjudgments of functional events have obscured the problem from the time of the original introduction of the syndrome up to the present time.

It does seem to hold true, however, that the syndrome complex arises within the temporomandibular joint and its surrounding tissues, as many orthodontists and dentists have noticed astonishing, recuperative results after (1) relieving the posteriorly displaced condyles in cases of posterior displacement or (2) opening the bite in cases of overclosure which exhibit the syndrome. When one does a functional analysis on these cases, crepitus and popping within the joints definitely can be determined; these, of course, are symptomatic of dysfunction. Cephalometric radiographs of many of these patients demonstrate upward and backward paths of closure of the mandible from the rest position to the occlusal position, which demonstrates a posterior displacement. Logically, in these posterior displacement cases there is compression and tension on tissues in the joint area. In some recent work, Carlson[3] showed that Class II, Division 1 cases of malocclusion, with an upward and backward path of closure, belong to the displacement type. Relief of the displacement reduced the apical base difference. This was done by carrying the mandible forward so that the condyles were in their most functional relationship to the articular surfaces of the temporal bones.

Seaver[4] maintained that in malocclusion there is abnormal position or posture and, therefore, abnormal movements begin and end in abnormal posture; that the abnormal posture and movements during mastication initiate abnormal afferent (proprioceptive) stimuli which create, through reflex action, an increased muscle tone with abnormal pressure either in the joint or on the axial planes, particularly of the incisor teeth, creating additional afferent (exteroceptive) stimuli within the distribution of the fifth cranial nerve; and that the tensor tympani muscle shares similar changes in muscle tone with the antigravity group, so that there is actuated an increased intralabyrinthine pressure transmitted through the ossicular chain and footplate of the stapes.

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I will not try to discuss all the symptoms constituting the syndrome, but I do feel that a possible explanation of dizziness or vertigo may be a stepping-stone for further research and understanding of the problem.

According to Best and Taylor,[5] it should be emphasized that with whatever condition vertigo is associated, whether cardiovascular, renal, toxic, gastrointestinal, or neurological, its immediate cause is excitation of the semicircular canals or of their central connections. If vertigo is thus dependent on the semicircular canals, there must be some association between the temporomandibular joints and the canals. Previously it was mentioned that posterior displacement and overclosure cases must demonstrate compression of tissue within the joints and abnormal tension on portions of the joint capsules. According to Sherrington,[6] any tension on ligamentous structures integrates impulses within the tendinous stretch receptors or tendinous spindles. These impulses can be carried along axons to Deiters' nucleus (lateral vestibular nucleus). Axons coming from the semicircular canals also synapse with cell bodies within the nucleus. Seaver[4] stated that changes in intralabyrinthine pressure are capable of exciting the end organ of the vestibular nerve, with resulting increased stimuli (proprioceptive) passing from it to Deiters' nucleus.

The afferent pathways for stretch receptors of the muscles of mastication and tendons attached to the mandible were confirmed by Corbin and Harrison.[7] Their work demonstrates conclusively that the mesencephalic root of the fifth cranial nerve of the cat mediates sensory impulses when the masticator muscles and tendons attached to the mandible are stretched. Corbin's[8] research, however, did not show pathways and collaterals to Deiters' nucleus. Probst sectioned the mesencephalic root of the fifth cranial nerve in the cat at different levels and studied the resultant degeneration. He traced a small bundle of medium-sized fibers in the reticular matter ventral to the vestibular nuclei and as far caudally as the exit of the vagus nerve. Collaterals were found passing from this tract to Deiters' nucleus. Weinberg[9] has also seen a descending bundle from the mesencephalic root of V passing toward Deiters' nucleus.

Axons synapsing with cell bodies in the vestibular nuclei relay impulses to the cerebellar nuclei via the vestibulocerebellar tract. Afferent fibers of this tract pass the impulses on to the three cerebellar nuclei—nucleus globosus, nucleus emboliformis, and mainly to nucleus fastigii.[10] Cell bodies within nucleus emboliformis[11] send axons into the brachium conjunctivum. The brachium conjunctivum is shaped like a thick crescent and forms the dorsolateral shoulder of the upper pontine levels, lying just laterally to the upper end of the fourth ventricle. More cephalad, it swings ventrally, its lowest fibers being cut quite obliquely in transverse sections. These fibers are the first to decussate. The crossed brachia are oval masses deep in the tegmentum. Here they are placed just caudad to the red nuclei. Some fibers end in the red nucleus; about one-fourth of the tract ends around the small cells of the red nuclei. It is likely that the large-celled portion is connected with the emboliformis, the small-celled portion with the dentate. Many of the fibers run

directly through the red nucleus and into the ventromedial part of the thalamus. Marchi degeneration experiments have shown these fibers to terminate finally in the anterolateral part of the ventral nucleus of the thalamus.

Posterior displacements are very common,[3] and cases of overclosure are numerous. Thousands and thousands of people in daily life live without the convenience of dentures; yet, patients exhibiting Costen's syndrome are few. One might think that the excessive number of impulses arising within the stretch receptors of patients with overclosure or posterior displacement would give rise to a greater incidence of the syndrome, but apparently the thalamus integrates[12] the impulses in such a manner that before the impulses reach the cerebral cortex they are associated in a normal sequence. In certain thalamic conditions, however, the thalamus loses some of its integrating powers, and the cerebral cortex thus is bombarded with numerous, unassociated impulses. The thalamus also can be considered as an inhibitory center, actually preventing excessive impulses from reaching the cerebral cortex. In certain conditions, the thalamus loses some of its inhibitory power and excessive numbers of impulses reach the cerebral cortex. Paralleling this concept, Dejerine and Roussy[13] first clearly described a classic thalamic syndrome in which spontaneous pain and subjective overresponse to pleasant and unpleasant stimuli are prominent features. It is also conceivable that Deiters' nucleus, under prolonged, repeated overstimulation, may become an "irritable focus."[4]

Impulses relayed through the anterolateral part of the ventral nucleus of the thalamus are projected upon areas 4 and 6 of the cerebral cortex, and, of course, from these areas internuncial neurons can carry the impulses to sensory areas of the cerebral cortex.

COMMENTS

If the thalamus and Deiters' nucleus function normally, the cerebral cortex is not bombarded with excessive vestibular (or should I say *vestibular-like*) impulses, even though the patient is in a state of malocclusion which may initiate excessive proprioceptive impulses. However, if the thalamus and Deiters' nucleus function abnormally and the syndrome complex is present, correction of the malocclusion or, in the case of the edentulous patient, correction of the overclosure or displacement will reduce the number of vestibular impulses that reach the cerebral cortex; consequently, the condition of vertigo may disappear, and the patient will be happy.

REFERENCES

1. Costen, J. B.: A Syndrome of Ear and Sinus Symptoms Dependent Upon Disturbed Function of the Temporomandibular Joint, Ann. Otol., Rhin. & Laryng. 43: 1-15, 1934.
2. Zimmerman, Arnold A.: An Evaluation of Costen's Syndrome From an Anatomic Point of View, Edited by Bernard G. Sarnat, Springfield, Ill., 1951, Charles C Thomas.
3. Carlson, Stanley D.: A Cephalometric Radiographic Study of the Change in Relation of Mandible to Maxilla in Orthodontic Treatment, Chicago, 1951, M.S.D. Thesis, Northwestern University Dental School.
4. Seaver, E. P.: Temporomandibular Joint Malocclusion and the Inner Ear, A Neuromuscular Explanation, Ann. Otol., Rhin. & Laryng. 46: 143-144, 1937.
5. Best, C. H., and Taylor, H. B.: Physiological Basis of Medical Practise, Baltimore, 1950, Williams & Wilkins Company, p. 969.

6. Sherrington, C. S.: On the Anatomical Constitution of Nerves of Skeletal Muscles; With Remarks on Recurrent Fibers in the Ventral Spinal Nerve-root, J. Physiol. **17:** 211-258, 1894.
7. Corbin, K. B., and Harrison, F.: Function of Mesencephalic Root of the Fifth Cranial Nerve, J. Neurophysiol. 3: 423-435, 1940.
8. Corbin, K. B.: Probst's Tract in the Cat, J. Comp. Neurol. 77: 455, 1942.
9. Weinberg, Ernest: Mesencephalic Root of the Fifth Nerve, J. Comp. Neurol. **46-47:** 386, 1928-29.
10. Best, C. H., and Taylor, N. B.: Physiological Basis of Medical Practise, Baltimore, 1950, Williams & Wilkins Company, p. 1059.
11. Krieg, Wendell J. S.: Functional Neuroanatomy, New York and Toronto, 1953, The Blakiston Company, pp. 467-468.
12. Ruch, Theodore D.: Fulton's Textbook of Physiology, Philadelphia, 1949, W. B. Saunders Company, p. 335.
13. Ruch, Theodore D.: Fulton's Textbook of Physiology, Philadelphia, 1949, W. B. Saunders Company, p. 345.

In Memoriam

HOWARD DUNN*

1894-1955

HOWARD DUNN, aged 61 years, died on Jan. 13, 1955, in Oakland, California, following a long illness.

A native of Denver, Colorado, he was graduated from the College of Physicians and Surgeons in San Francisco in 1916, and served overseas in World War I as an Army Captain in the Dental Corps.

He was associated with his uncle, pioneer California orthodontist Robert Dunn, who was our first president in 1913. Howard Dunn was a diplomate of the American Board of Orthodontics.

He served as secretary of the Alameda County Dental Society in 1929-30, becoming its president in 1931. He was also treasurer of the California State Dental Association in 1932.

He was a member of Yerba Buena Masonic Lodge #403, the Oakland Scottish Rite Bodies, and Aahmes Temple of the Shrine.

He is survived by a son, Howard C. of Oakland, and a sister, Mrs. Charline Orth of Los Angeles, to whom our sincere sympathies are extended.

ALLEN H. SUGGETT*

1867-1955

ALLEN H. SUGGETT died in Santa Barbara, California, on March 8, 1955. Born in Middletown, Missouri, on April 15, 1867, he came to California when he was 8 years old. On arriving in California, his family settled in the small town of College City in Colusa County. Here was located Pierce Christian College, one of two secondary schools in northern California. In May, 1888, Dr. Suggett received his degree in civil engineering.

He soon decided that dentistry was more attractive than engineering and found employment in a dentist's office. Becoming dissatisfied with this method of receiving a dental education, he entered the Dental Department of the University of California, from which he was graduated in 1893. He then practiced general dentistry in Marysville for thirteen years.

At the end of that time, he became interested in producing rubber in Mexico, and in that connection made a trip to the Malay Peninsula and around the

*Reprinted, with revisions, from the *Bulletin* of the Pacific Coast Society of Orthodontists.

world. When he returned to San Francisco after the fire in 1906, he took up orthodontics and was appointed professor at the University of California Dental Department. During his years of general practice, he had always kept in close touch with his Alma Mater. He retired from active practice in 1930 when he moved to New York, where he was connected with the Orthodontic Department of Columbia University for several years. The last years of his life were spent in Santa Barbara.

Dr. Suggett was always interested in young people and their struggles to get an education. He advanced thousands of dollars, most of which he neither demanded nor expected to be repaid.

In addition to serving as president of the Pacific Coast Society of Orthodontists, his contributions to orthodontics were many.

Surviving him are a brother, a sister, and numerous nieces and nephews. His wife, Laura Steffens Suggett, died in 1946.

Allen E. Scott.

HARRY STRUSSER

1896-1954

THE Northeastern Society of Orthodontists and the specialty of orthodontics lost a devoted friend with the passing of Dr. Harry Strusser on May 17, 1954, in his fifty-eighth year, after a long, outstanding, and distinguished career. He is survived by his wife, Mrs. Anna Strusser, and two daughters, Mrs. Millicent S. Simon and Mrs. Rosalyn S. Nacht.

After having been graduated in dentistry from New York University in 1918, his attention soon turned to the public health aspect of dental service, and it was this strong attraction that directed the major portion of his career into this most important field.

Among the list of his postgraduate pursuits are to be found courses in medicosocio- and medicodental economics and dental caries control techniques at the University of Michigan, and the degree of Master of Science in Public Health from Columbia University, which he received in 1945. Other training and experience in public health enterprises included:

1. Dentist-in-Charge, Child Welfare Board Dental Clinic, 1922-28.
2. Visiting Dentist, New York Parental School, Department of Education, 1923-26.
3. Assistant Supervising Dentist, Department of Health, New York City, 1939-41.
4. Chief, Division of Dental Service, Department of Health, New York City, 1931-47.
5. Director, Bureau of Dentistry, Department of Health, New York City, 1947-54.
6. Consultant, Works Progress Administration, U. S. Government, 1937-40.

He also held various teaching appointments in dental public health practice and preventive medicine at such universities as Columbia, New York, Michigan, Harvard, and Pennsylvania.

Dr. Strusser was a diplomate of the American Board of Dental Public Health and had received several honors and awards for outstanding achievement in dental public health. He was the author of some forty-odd papers on various phases of dental health service and collaborated in the writing of three textbooks.

In 1945, when the New York State Legislature decreed that dentofacial involvements were to be included under the Crippled Children's Act, Dr. Strusser set to work on the project with his characteristic zeal, organizing the

HARRY STRUSSER

facilities of the Bureau of Dentistry to cooperate with the Bureau for Handicapped Children. Dr. Strusser came to the Northeastern Society of Orthodontists and asked for its cooperation in the organization of the orthodontic program of the Department of Health of the City of New York. Our Society, ever mindful of its public health obligations, appointed a committee to cooperate in this work. At the present time, orthodontists are serving the City of New York in a consultative capacity in the program. This orthodontic project, now completing its tenth year of operation, has been a remarkable achievement and is now well established as a permanent service. It was largely through Dr. Strusser's highly developed administrative ability and his adherence to the guidance of his Orthodontic Advisory Committee that this massive undertaking was so successful.

A brief review of the first ten years of the orthodontic rehabilitation program reveals the following figures:

1. Number of orthodontic operators on the City Panel—167.

2. Total number of orthodontic cases presented for screening—5,458.

3. Total number of cases approved—1,990.

At present there are approximately 1,500 children receiving active treatment under the New York City program.

On March 8, 1954, just over a year ago, Dr. Strusser and Dr. Louis A. Simon (Assistant Director) presented a classical paper here before our Society, entitled "Orthodontics in Public Health Service." This paper was published in the AMERICAN JOURNAL OF ORTHODONTICS in September, 1954. From the inquiries, comments, and reference which have come back to the JOURNAL, it has become the opinion of the editorial staff that, in reader interest, guiding influence, and valuable information in a vital field, it is one of the outstanding papers published in the forty years of the JOURNAL's existence.

Ever reliable and dependable, Dr. Strusser, through the effervescence of his smile and the warmth of his personality, endeared himself in the hearts of a great host of personal and professional friends. He was a firm believer in the following quotation set forth in the words of Phillips Brooks: "He who helps a child helps humanity with an immediateness which no other help given to human creatures in any other stage of life can possibly be given again."

Whereas, Harry Strusser was a staunch and loyal supporter of orthodontics and an outstanding pioneer in the development of orthodontics as a public health service;

Whereas he was a real benefactor to orthodontics and, through it, to mankind; and

Whereas the Northeastern Society of Orthodontists, with deep emotion, does mourn his loss,

Be it therefore resolved that these resolutions be recorded in our minutes and a copy be sent with our deepest sympathy to his family.

Respectfully submitted,

Joseph D. Eby.

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Cephalometric Registrations as an Aid in Diagnosing Malocclusions: By Anders Lundstrom. *Acta odontol. scandinav.* **11**: 100-110, November, 1953.

Simon determined the relation of the dentition to three mutually perpendicular planes: the *ear-eye plane* (approximating the Frankfort horizontal plane), the *median plane* (through the median line of the palate), and the *orbital plane* (through the mean of the two orbital points in the anteroposterior direction). Simon has also discussed in detail the conception of a "norm," explaining how it might be defined with respect to the relation of the dentition to these planes. He maintains that it is impossible to determine a norm for each person. It is necessary, therefore, to judge each case according to a standard common to all. This is obtained by calculating the arithmetic mean of a number of cases with "anatomically correct occlusions" which have been selected from the population.

A selection such as that envisaged is always based on an empirical normal conception, involving a degree of subjectivity varying with the limits set; all workers cannot be expected to employ quite the same limits. Apart from this more theoretical objection, it is by no means certain that treatment aiming for a mean for normal cases (mean norm) will result in any improvement in the individual case. The aim of all orthodontic treatment should be to convert inferior dentitions into satisfactory ones—*functionally* (in respect to chewing, speech, and breathing), *prophylactically* (in respect to caries, periodontal, and joint diseases) and *esthetically*. It is doubtful whether these points will receive more specific attention if a mean norm is aimed at.

Simon considers it practical to distinguish between the two types of postnormal cases in which either the upper or lower jaw displays anteroposterior deviation from the average relationship between orbital plane and dentition.

For example, in the case of postnormal occlusion with protraction of the maxilla, the primary object is to guide the maxilla back, whereas in the case of mandibular retraction it is the mandible that should be corrected.

Simon maintains that these principles of treatment are of value both esthetically and in the attempt to obtain permanent results. The human profile is so complicated and varying that it is only possible to conceive an esthetic opinion of it in the individual case, bearing in mind the size, shape, and mutual relation of all the parts that compose it.

It may be found, for example, that a profile with a comparatively large nose will appear more harmonious if it is combined with a bimaxillary protraction than if the two jaws have an average relationship to the orbital plane. Similarly, a protruding chin will have a striking effect on the profile—a fact that should be given due consideration when a change in the dentition is projected for esthetic reasons. It would appear impossible, therefore, to

prescribe a mean norm which would insure an esthetically satisfactory result. The esthetic viewpoint is inherently subjective and should not be prejudiced by irrelevant metric construction.

A factor of special importance is the permanency of the result. Postnormal occlusion again may be taken as an example. Such cases can be treated either by retracting the maxilla (or by checking its forward growth) or by encouraging the forward growth of the mandible. Which of these alternatives is likely to yield the more stable results is, so far, unknown.

In the absence of any definite knowledge on this point, it would seem more consistent to make an esthetic estimation (however subjective it may be) the basis for reconstruction of anteroposterior malocclusions. If there is little to choose between a maxillary and a mandibular displacement from an esthetic point of view, it might prove advisable to center the reconstruction on the jaw for which the anteroposterior displacement is most easily effected for the malocclusion in question.

This reasoning may be equally applied to analyses of individual deviations from the mean norms obtained from profile radiographs. With the x-ray picture of the profile as a basis, it may be easier to determine the type and the extent of the changes planned in the dentition than with just an ordinary clinical examination and, at the same time, it is easier to judge the limitations of the treatment. Where wider clinical experience is lacking, profile radiographs will be found a great advantage. Such assessments of the differences between the existing and the projected profiles are not concerned with the mean norm but are purely individual assessments.

The simplest way of defining the limits for the normal variation is by means of the maximum and minimum values in a material. Such a procedure is unsuitable, however, as the boundary values are largely arbitrary and, moreover, dependent on the number of cases investigated (an increase in material giving a greater range).

The standard deviation also has been employed for determining the normal variation. As an example, practically the whole variation (99.7 per cent) is to be found within the limits, ±3 times the standard deviation, calculated from the mean value, and values outside these limits can be regarded as abnormal. Naturally, this does not mean to say that such an extreme variant, simply because it is abnormal, is characterized by any imperfect state involving need of treatment. That would be tantamount to maintaining, for example, that a man whose height is more than 196.2 cm. is defective in his development. Generally speaking, one can talk of need of treatment only for individual patients who are inconvenienced in some way by their abnormality.

A factor whose significance has been discussed in connection with the prognosis of the anteroposterior malocclusions is to be found in the inclination of the so-called Y axis (a line from the center of the sella turcica to the gnathion) to the Frankfort horizontal plane. Take, for example, a postnormal dentition in which this angle is comparatively large (so that the height of the face is great in relation to its depth at gnathion); the prospect of correction would be less than if the angle were small (the depth of the face being large in relation to its height). This would explain a more pronounced forward development of the mandible in the latter cases than in the former in which the growth of the face is more vertical. The degree to which the inclination of the Y axis can be used as a measurement of the forward growth of the mandible is uncertain, however. This angle is, in fact, determined partly by the height of the face, and there is no reason to presume that a comparatively great height would be associated with a small forward growth of the mandible.

The variation in the forward development of the jaws would be best determined by successive x-ray observations of the individual profile. Such particulars

may facilitate a better prognosis, although a detailed treatment of extensive material would be necessary in order to provide convincing evidence. The same applies to the inclination of the mandibular plane in relation to the Frankfort horizontal, for example, to which angle Tweed and others attribute great significance in the prognosis for postnormal occlusion, since a large angle would imply a poor prognosis.

The registrations of the freeway space and the path of closure for the mandible from the physiologic rest position to occlusion deserve special mention. In connection with prenormal occlusion, such registrations are of obvious value in differential diagnosis. By this means it should be possible to distinguish between "forced prenormal occlusion," on the one hand, in which the mandible is forced forward during closure by incorrect incisal guidance, and, on the other hand, the true prognathous mandible with abnormal forward development. In the treatment of prenormal occlusion it is usually a simple matter to control clinically the path of closure by noting it when the mandible is relaxed and checking whether the patient can bite edge to edge, or nearly so, with the incisors. Such clinical determinations have been in use for a long time for these cases. In a case of "forced prenormal occlusion" it may be necessary only to correct the inclination of the incisors in order to achieve normal occlusion.

In postnormal occlusion, however, a corresponding registration is appreciably more difficult to carry out clinically. There is a demand, therefore, for a method that will illustrate the degree to which these malocclusions are connected with forced occlusions, and which might provide a better prognosis than is possible at present in cases of malocclusion caused by abnormal relative anteroposterior growth of the jaws. It may prove that the best advance in this direction is gained by making profile x-ray studies of the mandible in a rest position and in occlusion, as pointed out by Thompson.

Accurate determinations of the error inherent in the method are essential, however (particularly in registration of the rest position), before it will be possible to decide the true value of this method.

The registration of the displacement of the mandibular condyle in closure from the rest position to occlusion is of particular importance when determining whether there is any postnormal "forced malocclusion." In the normal state no parallel displacement is assumed to take place; it is a hinge movement. In the postnormal "forced malocclusion," however, there is a displacement of the condyle backward and upward, in consequence of which condylar photographs must be regarded as essential complements to the profile radiographs in the examination.

One possibility of an erroneous diagnosis which perhaps may be pointed out derives from the tendency that is shown by certain patients with postnormal occlusion to protrude the mandible in order to improve the profile. Such a fixed habit is a "forced malocclusion" in a backward direction, whereas in point of fact it is the registered "rest" position that is a "forced" position—forward. This possibility is not contradicted by Ricketts' discovery that the difference between cases with "normal" path of closure and cases with backward and upward thrusting of the condyle from rest to occlusion seems to depend upon different rest positions does not contradict this possibility. Another explanation of his finding is, of course, that the morphology of the jaw joint is determined in relation to the position of the mandible in occlusion but not to the rest position.

Great value should be attached to all attempts that are being made to demonstrate the success gained in changing the profile in the upper and lower jaws by various methods (intermaxillary traction, treatment with plates, and the use of occipital anchorage). This can be carried out most simply with the aid of cephalometric methods.

Differences between radiographs before and after treatment are often difficult to interpret, and not least when they relate to long-term treatment of children. In these cases considerable development is going on simultaneously with the treatment, the growth varying appreciably from one case to another.

Orthodontie in der Taglichen Praxis. (Orthodontics in the Daily Practice): By Prof. Dr. Med. R. Hotz. Published by, Hans Huber, Bern, Switzerland, 1954. 314 pages, with 960 illustrations.

The present work is an enlargement of a previous book by the same author on *Orthodontic Education for the Practicing Dentist.* Hotz depends largely on illustrations to present to the practitioner information of a practical nature. This book is not intended to replace any of the basic orthodontic texts now in use. In the introduction, Hotz discusses the aims, limitations of treatment, and the principal types of malocclusion. In an investigation of 2,500 children in Zürich, he found 55 per cent with overbite, 30 per cent with crowding, 80 per cent showed Class I (Angle), and 17.2 per cent Class II (Angle) malocclusions.

After discussing etiological factors, Hotz presents an account of developmental failures. He does not agree with the reviewer that "some day we may know the specific etiology of any particular form of malocclusion." The intended meaning of the foregoing actually is that it may be a probability but it is not considered a possibility in the light of present knowledge.

A succinct review is presented of the etiology and classification of malocclusion. The author differentiates between positional anomalies of teeth and interarch malocclusion. In the discussion on general therapy, Hotz advises caution and points out that the ease with which teeth can be moved does not assure moving them in the proper direction or keeping them in the desired position.

Orthodontic aids in the early treatment of developing malocclusion are discussed and illustrated. These consist mostly of the loose- and tight-fitting plates commonly used in Europe. Descriptions are provided of the construction and use of the Andresen-Häupl activator, the Robin Monobloc, the vestibular screen, and the Propulsor appliance which is a combination of the vestibular screen and the Monobloc.

In his discussion of the systematic extraction of permanent first molars, Hotz includes "social indication" for extraction. This, he points out, does not refer to the inability of the patient to pay for conservative treatment. It means, according to Hotz, that when the government takes over the dental treatment of children, it assumes also the right to limit treatment and to decide on compromises of treatment which depend on following more easily obtained results as against the ideal requirements. This brings about a type of socialized dentistry which is not concerned with the requirements of the individual patient, as is the case in private practice, but is directed along arbitrarily generalized lines. The government is not interested in the sequelae of compromise treatment as long as it does not have the responsibility of taking care of the adults. Hotz warns against allowing socialized dentistry to adopt methods which are not generally acceptable in the dental field.

Extraction of permanent first molars is discussed at some length. Hotz agrees with this reviewer's findings, based on 10,000 children in the New York City vocational schools, that permanent first molar extraction leads to an increase in malocclusion. He quotes the work of Lutz of Zürich (on 400 children) that disturbances of occlusion follow permanent first molar extractions.

The chapter on special therapy presents much practical information for the practitioner. The illustrations and captions supplied in explanation will be found of great value.


PERMANENT TOOTH

Unpunched: present
Punched: missing
Deep punched: extracted

GINGIVAE
1: normal
2: local irritants
3: hypertrophic
4: recessive
5: ulcerative
6: periodontitis
7: periodontosis

FACE TYPE
1: leptoprosopic
2: mesoprosopic
3: euryprosopic
4: gross asymmetry

HEAD FORM
1: dolichocephalic
2: mesiocephalic
3: brachyocephalic
4: gross asymmetry

HEIGHT
1: 39" 6: 54" 11: 66"
2: 42" 7: 57" 12: 68"
3: 45" 8: 60" 13: 70"
4: 48" 9: 62" 14: 72"
5: 51" 10: 64"

WEIGHT
1: 50 6: 100 11: 150
2: 60 7: 110 12: 160
3: 70 8: 120 13: 170
4: 80 9: 130 14: 180
5: 90 10: 140 pounds

MALE

AGE

SAUL M. BIEN, D. D. S.
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Angle Classification
1: Class I
2: Class II, Div. 1
3: Class II, Div. 1, subdiv.
4: Class II, Div. 2
5: Class II, Div. 2, subdiv.
6: Class III
7: Class III, subdiv.

CONGENITALLY ABSENT TOOTH
CONGENITALLY ABSENT PERMANENT TOOTH, DECIDUOUS TOOTH PRESENT
EXTRACTED TOOTH, CARIES
EXTRACTED TOOTH PERIODONTAL DISEASE
EXTRACTED TOOTH ORTHODONTIC PURPOSES
EXTRACTED TOOTH, CAUSE UNKNOWN
SUPERNUMERARY TOOTH

EXTRAVERSION: RIGHT MAXILLARY, RIGHT MANDIBULAR, ANTERIOR MAXILLARY, ANTERIOR MANDIBULAR, LEFT MAXILLARY, LEFT MANDIBULAR
INTRAVERSION: RIGHT MAXILLARY, RIGHT MANDIBULAR, ANTERIOR MAXILLARY, ANTERIOR MANDIBULAR, LEFT MAXILLARY, LEFT MANDIBULAR
SUPRAVERSION: RIGHT MAXILLARY, RIGHT MANDIBULAR, ANTERIOR MAXILLARY, ANTERIOR MANDIBULAR, LEFT MAXILLARY, LEFT MANDIBULAR
INFRAVERSION: RIGHT MAXILLARY, RIGHT MANDIBULAR, ANTERIOR MAXILLARY, ANTERIOR MANDIBULAR, LEFT MAXILLARY, LEFT MANDIBULAR
MEDIAN LINE DEVIATION

RELATIONSHIP OF THE TEETH

Unpunched: tooth in normal relationship
Punched: tooth grossly out of position in the arch
Deep punched: tooth impacted

TORSIOVERSION, TOOTH
TRANSVERSION, TOOTH
IMPACTED, TOOTH
FRACTURED TOOTH
ERODED, PITTED, HYPOPLASTIC, DISCOLORED TOOTH
DENTAL ANOMALY
ORAL ANOMALY

(For explanation, see abstract of "Registration of Orthodontic Diagnostic Records for Statistical Evaluation" by Saul M. Bien, on opposite page.)

Chapter VII, on techniques, is devoted largely to a review of the construction of plates as used in Europe. The work contains much useful information and should prove of interest to American practitioners.

J. A. S.

Registration of Orthodontic Diagnostic Records for Statistical Evaluation: By Saul M. Bien, B.A., D.D.S.

Orthodontic diagnostic data which can be accumulated in a related form by research and study groups in different ethnologic or geographic areas could present information of important scientific value.

Three hundred five different items abstracted from the history, physical examination, radiographs (full mouth, lateral jaw, and cephalometric), photographs, and models may be registered on the punch card in code. Space is provided on the face or back of the card for written registration of cephalometric and other anthropometric data.

The terms used are taken from the list approved by the Nomenclature Committee of the American Association of Orthodontists and appear in their 1948 report. The teeth are numbered according to the Universal system, starting with the upper right as No. 1 and ending with the lower right as No. 32. Registration of the coded data is made on a standard 8 by 10½ inch McBee Keysort card—#KS 811 B. (See illustration on opposite page.) The registration is done with a small hand paper punch similar to a conductor's punch. The sorting is done with a hatpin.

Lehergang der Gebissregelung. (Course of Study in Orthodontics.) Vol. 2, Treatment: By Professor A. Martin Schwarz, Chief of the Jaw Orthopedics Division of the Vienna City Polyclinic. Published by Urban and Schwarzenberg, Vienna, 1953. 987 pages, with 572 illustrations.

Volume 1 deals with the examination of the patient. In Volume 2, under present discussion, Schwarz reviews the biologic basis of orthodontic procedure as evidenced in histologic sections. The mechanical principles in orthodontics are presented under "Anchorage," "The Application of Forces," and "The Effect on the Teeth of Orthodontic Forces."

Under "Orthodontic Appliances and Their Method of Application," the author briefly describes, among others, the Angle expansion arch and the Angle edgewise appliance. The Johnson twin-arch mechanism is described. A detailed account is presented of the Mershon removable lingual arch, along with the labiolingual appliances of Korkhaus. A discussion follows on the use of the combined Mershon lingual and Lourie high labial appliances. The construction of the foregoing appliances is described and illustrated.

Emphasis placed by Schwarz on appliances to be used in "jumping the bite" and on "expansion" of dental arches is indicative of the need for further correlation of methods of treatment to our present understanding of orthodontic limitations in order to avoid the high percentage of relapses of treated cases that were a more common occurrence in former years, at least in America, when these methods were in vogue.

Fig. 175 on page 257 shows the use of the Herbest gliding hinge attachment followed by condylar growth in the treatment of distoclusion. The effect of the Herbest hinge is to "jump" the bite, a method of treatment which was not found successful in America and is rarely used today.

More than one-third of this volume is devoted to the discussion of removable appliances. It is apparent that Schwarz, like most of the European orthodontists, has much to say in favor of removable appliances, especially the use

of plates. He quotes Nord as prophesying, at the Heidelberg meeting of the European Orthodontic Society in 1929, that "the plate is the appliance of the future."

The author attempts to explain the failure of American orthodontists to avail themselves of the use of plates in treatment. He points out, among other reasons, the reluctance of the American orthodontist (although he does not specifically designate him) to rely too much on the cooperation of the patient in obtaining successful treatment. This reviewer considers this a valid reason, but there are other reasons, even more valid, why the use of plates in America is not popular. Not the least of these is the fact that so much can be accomplished with wire appliances which are not more costly in the long run than plates that require at least as much time in their construction.

Schwarz claims that plates bring about growth and widening of the palatal processes of the maxillae and, as such, can be truly considered to be jaw orthopedic appliances in contradistinction to fixed appliances which affect tooth position only. This is a question which received a great deal of discussion in the United States a quarter of a century ago. It now appears that American orthodontists do not consider random arch expansion to be of a permanent nature. At least, in the United States it has been found that function has the last word when all appliances are removed. Thus far, experimental work on dogs, as well as on human beings, has been insufficient to warrant conclusions such as those claimed by Schwarz.

The activator appliance of Andresen-Häupl and its modifications receive full discussion. The method of constructing the activator is presented in detail. There are two basic requirements which activators must possess: they must rest loosely on the dental arches and they must be constructed in such a manner that each closure or functional movement of the jaw contributes toward moving the teeth toward normal occlusion. These desiderata require careful planning and proper positioning of the activator. However, planning and positioning of activators are at least as difficult to learn as any of the fixed appliance techniques.

Extraction of teeth as an orthodontic measure receives detailed discussion. Axel Lündstrom, whose publications dealing with the relationship of the dental arch and the "apical base" to investing bone, the so-called "basal bone" of the jaws, is given credit by Schwarz as being the first to call attention to the condition which can be solved by extraction only. A historical and practical account is presented of extraction therapy as an adjunct as well as a sole method of treatment. The author correctly points out that crowding of teeth per se is not the basis of determining the need for extraction. The decision to extract must be based on tooth relationship to "basal bone."

Schwarz refers widely to the European orthodontic literature. His reference to the work of American authors, especially those who have made important contributions during the past decade, is limted. Readers who have a command of the German language will find this text interesting, especially as it presents European orthodontics. This is an important contribution to the literature on orthodontics and should receive consideration and study by all practitioners in this field.

J. A. S.

News and Notes

Middle Atlantic Society of Orthodontists

The Middle Atlantic Society of Orthodontists will hold its next annual meeting Oct. 5, 6, and 7, 1955, at the Shoreham Hotel in Washington, D. C.

Southern Society of Orthodontists

The Southern Society of Orthodontists will hold its next annual meeting in Charlotte, North Carolina, Sept. 25 through 28, 1955, at the Charlotte Hotel.

Southwestern Society of Orthodontists

The next meeting of the Southwestern Society of Orthodontists will be held in Wichita, Kansas, at the Broadview Hotel, Oct. 16 through 19, 1955.

Mexican Orthodontic Association

Dr. J. A. Salzmann of New York presented a series of lectures before the Mexican Orthodontic Association in February, 1955. Dr. Salzmann was presented a certificate of honorary membership in the Mexican Orthodontic Association.

Notes of Interest

Dr. S. Stuart Crouch announces the association of Donald G. Woodside, B.Sc., D.D.S., practice limited to orthodontics, 185 St. Clair Ave. West, Toronto, Canada.

Sumio Kubo, D.D.S., announces his return from military service and the reopening of his offices at 204 Mason Bldg., Fresno, California, practice limited to orthodontics.

Harold E. Leslie, D.D.S., announces the removal of his office to 386 Bloor St., West, Toronto, Ontario, Canada, practice limited to orthodontics.

Nathaniel Moss, D.D.S., 124 Parker Ave., Maplewood, New Jersey, announces the opening of an additional office at 207 S. Clinton St., East Orange, New Jersey, practice limited to orthodontics.

Dr. Joseph A. Sheldon, 3635 Johnson Ave., Riverdale 63, N. Y. C., announces the removal of his office to 4700 Bergenline Ave., Union City, New Jersey.

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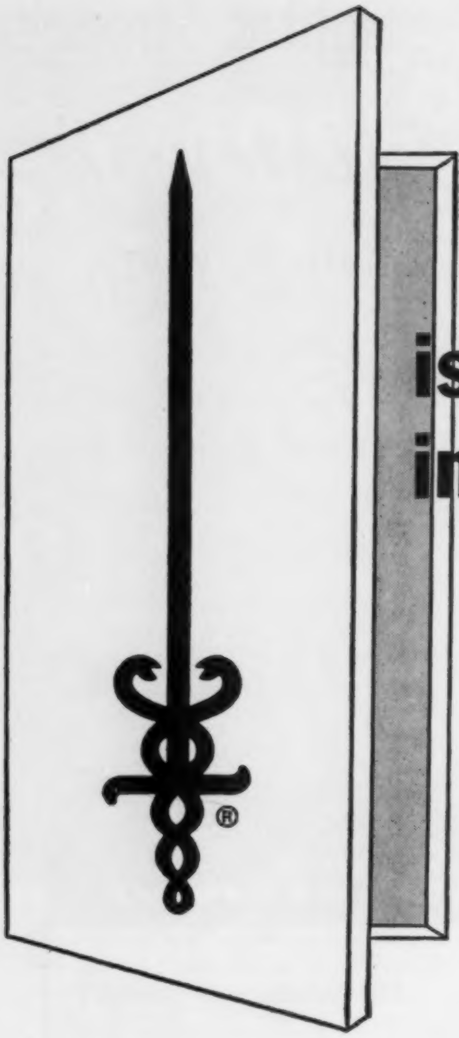

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